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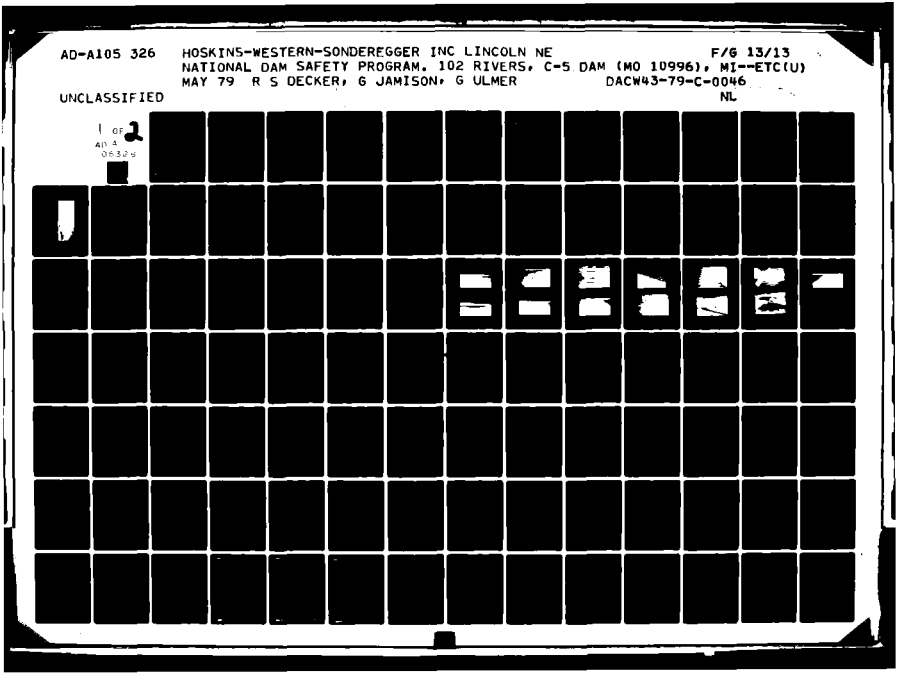

LEVEL II

MISSOURI-NEMAHA-NODAWAY BASIN

102 RIVERS, C-5 DAM

NODAWAY COUNTY, MISSOURI

MO. 10996

AD A105326

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

MAY, 1979

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National Dam Safety Program
102 River Trib Wtrshed Dam C-5 (MO 10996)
Nodaway County, Missouri

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This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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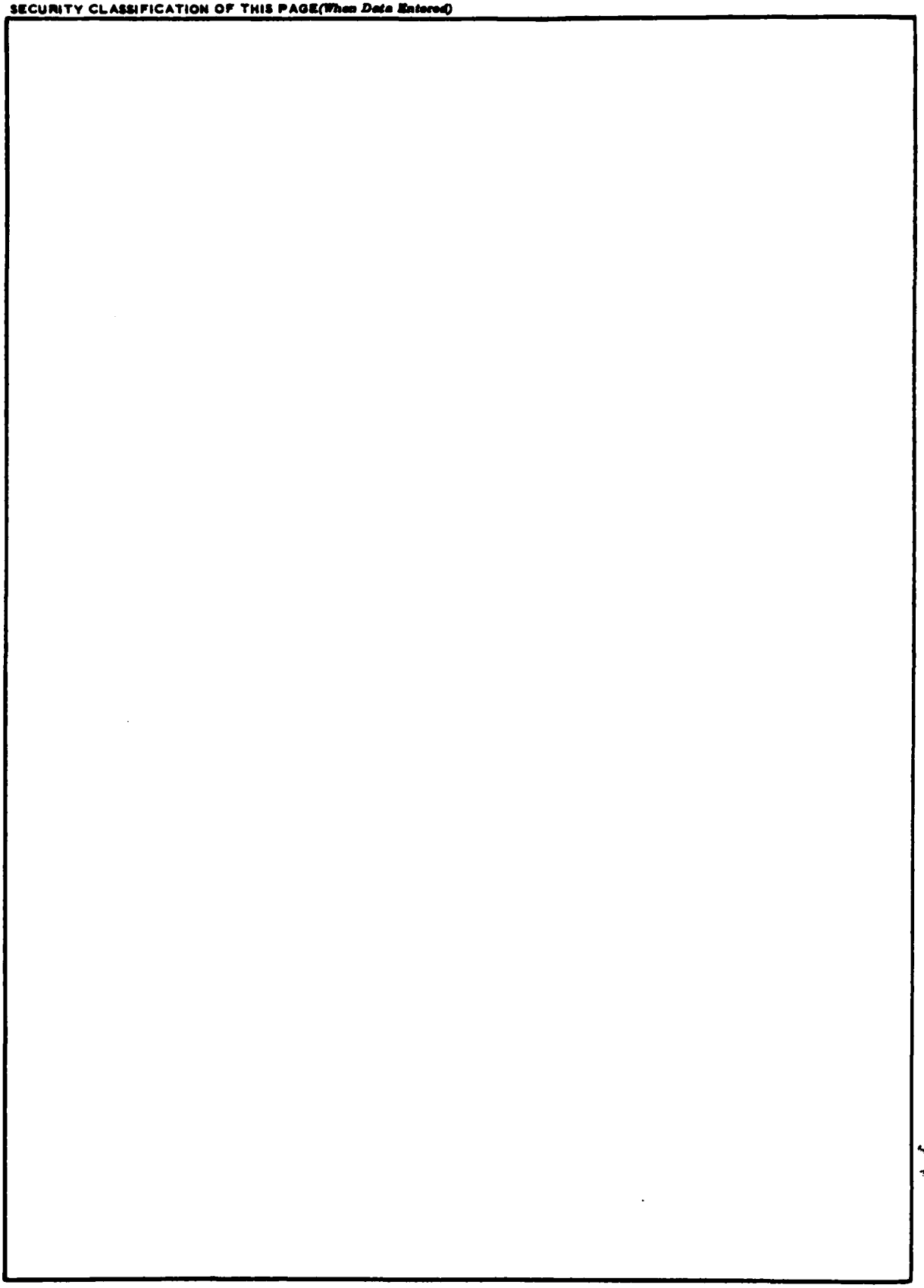

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102 RIVERS, C-5 DAM

NODAWAY COUNTY, MISSOURI

MO. 10996

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

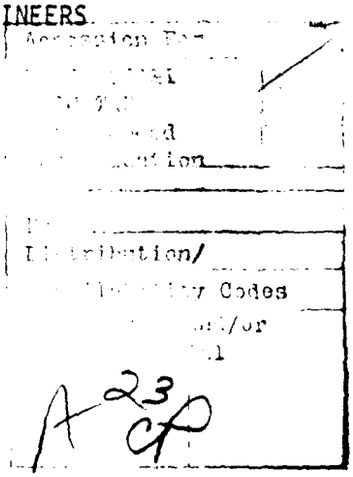
UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

MAY, 1979



DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: 102 Rivers, C-5 Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the 102 Rivers, C-5 Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood.
2) Overtopping could result in dam failure.
3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY SIGNED — Chief, Engineering Division — 24 SEP 1979 — Date

APPROVED: SIGNED — Colonel, CE, District Engineer — 24 SEP 1979 — Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	102 Rivers, C-5 Dam
State Located	Missouri
County Located	Nodaway County
Stream	Canal Branch 102 River
Date of Inspection	May 14, 1979

102 Rivers, C-5 Dam, was inspected by an interdisciplinary team of engineers, ~~from Hoskins-Western-Sonderegger~~, Inc. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends about one to two miles downstream of the dam. Within the damage zone are State Highway 148 at 0.6 mile downstream, a trailer home at 0.7 mile, two dwellings and a county road crossing at 1.1 miles and two dwellings and a county road crossing at 1.3 miles.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Considering the downstream hazards involved and the amount of water impounded, 50% of the Probable Maximum Flood is the appropriate spillway design flood. The spillway will pass the 100-year flood (flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillway will pass 35% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meterologic and hydrologic conditions that are reasonably possible in the region.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

Other than minor seepage in the right abutment trough and along both sides of the principal spillway basin, and some minor erosion of the upstream berm, no other deficiencies were observed.

The dam and appurtenances look very good and are well maintained.

Rey S. Decker
E-3703

Gordon Jamison

Garold Ulmer
E-4777

Harold P. Hoskins
Chairman of Board
Hoskins-Western-Sonderegger, Inc.
E-8696

PHOTO NO. 1 - OVERVIEW, DAM IN CENTER OF PICTURE

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
102 RIVERS,C-5 DAM - MO 10996
NODAWAY COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of 102 Rivers, C-5 Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams", dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth fill approximately 850 feet in length with maximum height of about 35 feet. Topography adjacent to the dam is gently rolling. Soils on the slopes are derived from fine grained glacial till. Upland soils are derived from loess. From boring logs shown on the plans, the foundation soil appears to be silty clay alluvium underlain by dense clay till.

(2) The principal spillway is uncontrolled and consists of a reinforced concrete riser with a 36 inch diameter reinforced concrete pipe conduit outlet.

(3) A vegetated earth emergency spillway is cut into glacial till on the left (north) abutment. It has a bottom width of 100 feet and side slopes of 3H on 1V.

(4) A 16-inch reinforced concrete drawdown pipe with stem gate control extends from the principal spillway riser to an inlet structure in the reservoir (invert elevation - 1039.0).

(5) Pertinent physical data are given in paragraph 1.3 below.

b. Location. The dam is located in the north central part of Nodaway County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the NW¼ of Section 29, T65N, R35W. The lake formed behind the dam is shown in the E½ of NW¼ of Section 29, T65N, R35W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the small size category.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph "c" above. Based on referenced guidelines, this dam is in the High Hazard Classification. The estimated damage zone extends about one to two miles downstream of the dam. Within the damage zone are State Highway 148 at 0.6 mile downstream, a trailer home at 0.7 mile, two dwellings and a county road crossing at 1.1 miles and two dwellings and a county road crossing at 1.3 miles.

e. Ownership. The dam is owned by the 102 Rivers Tributary Watershed Subdistrict, the Nodaway County Soil and Water Conservation District, P. O. Box 406, Maryville, Missouri 64468.

f. Purpose of Dam. The purpose of the dam is flood retardation.

g. Design and Construction History. The dam was constructed in 1975. The design and the plans for construction were prepared by the Soil Conservation Service (SCS), Columbia. Missouri. Portions of these plans are included with this report as Appendix C.

h. Normal Operating Procedure. There are no controlled outlets for this dam. Information was not available relative to the history of flows (if any) over the emergency spillway, or to the operation of the drawdown facility.

1.3 PERTINENT DATA

a. Drainage Area. 1398 acres (2.18 square miles).

b. Discharge at Damsite.

(1) All discharges at the damsite are through an uncontrolled reinforced concrete drop inlet pipe principal spillway and a grassed earth channel ungated emergency spillway.

(2) Estimated maximum flood - unknown.

(3) The principal spillway capacity varies from 0 c.f.s. at elevation 1051.0 feet (orifice elevation) to 43 c.f.s. at elevation 1056.0 feet (riser weir crest) to 167 c.f.s. at elevation 1065.1 feet (settled top of dam).

(4) The emergency spillway capacity varies from 0 c.f.s. at its crest elevation 1060.6 feet to 2080 c.f.s. at elevation 1065.1 feet (settled top of dam).

(5) Total spillway capacity at the minimum top of dam is 2250 c.f.s.±.

c. Elevations (feet above M.S.L. From Plans and B.M.C.-5)

(1) Top of dam - 1065.1 (settled)*
(2) Principal spillway orifice crest - 1051.0*
(3) Principal spillway weir crest - 1056.0
(4) Emergency spillway crest - 1060.6*
(5) Streambed at centerline - 1030
(6) Maximum tailwater - 1032.0
* Measured in field

d. Reservoir. Length (feet) of maximum pool - 2,650 feet±.

e. Storage (Acre-feet).

(1) Top of dam - 990±
(2) Principal spillway crest - 280±
(3) Emergency spillway crest - 470±

g. Dam.

(1) Type - earth fill
(2) Length - 850 feet (plans)
(3) Height - 35 feet
(4) Top width - 18 feet (plans) 20 feet (measured)

(5) Side Slopes.
   (a) Downstream - 2.5H on 1V (measured 2.6 to 2.7H on 1V)
   (b) Upstream - 2.5H on 1V down to berm (measured 2.8H on 1V on exposed slope, 3H on 1V below berm).

(6) Zoning - Selective placement of CL-CH glacial till material in center with CL-ML alluvial material from flood pool in outside shells. These data were taken from SCS plans in Appendix C.

(7) Impervious core - as above.

(8) Cutoff - 4 to 10 feet in depth into glacial clay till.

(9) Grout curtain - None

(10) Wave protection - Sacrificial berm and vegetation.

(11) Internal drainage - none found by inspection team.

h. Diversion Channel and Regulating Tunnel. None.

i. Spillway

(1) Principal

   (a) Type. Standard SCS reinforced concrete riser with drop inlet and 36 inch reinforced concrete pressure pipe conduit with two open ports on the right (south) side of riser. Ports are 2x1 feet. Plans show 5 antiseep collars on conduit.

   (b) Crest (invert) elevation - 1056.0 feet, ports at 1051.0 feet (measured).
   Outlet - 1032.4 feet (measured).

   (c) Length - 176 feet.

(2) Emergency

   (a) Type - Vegetated earth cut into glacial clay till.

   (b) Control section - 100 foot bottom width with 3H on 1V side slopes.

   (c) Crest elevation - 1060.6 feet (plans).

   (d) Upstream channel - clear and well grassed with slope of 1%.

   (e) Downstream channel - clear and well grassed with slope of 5%.

j. Regulating Outlets. 16 inch diameter reinforced concrete drawdown pipe with 16 inch rising stem gate with invert elevation of 1039 feet (from plans).

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Data on the geologic investigation, hydraulic/hydrologic computations, construction plans, and the soil mechanics/soil engineering report were supplied by the Soil Conservation Service, Columbia, Missouri. This information is shown in Appendix C.

2.2 CONSTRUCTION

No construction data were readily available; however, it is reported by SCS officials that the dam was constructed with SCS engineering supervision and standard inspection and quality control procedures.

2.3 OPERATION

No information was available on the maximum loading on the dam.

All spillways are uncontrolled.

No information was available on operation of the draw-down system.

2.4 EVALUATION

a. Availability. The engineering data shown in Appendix C was readily available from the Soil Conservation Service, Columbia, Missouri.

b. Adequacy. The available data and reported information are adequate for a general assessment of the design and stability of the structure. It should be noted, however, that the soil engineering recommendations called for a trench drain at c/b ratio of 0.6 and consisting of a well graded sand and gravel. No drainage system is shown on the plans nor was it observed in the field. The soil engineering report also recommended a 10 foot downstream berm. Although a drainage system was evidently not constructed for this dam, the plans show that the downstream berm is 18 feet rather than 10 feet wide. (This was verified in the field.) Seepage and stability analyses conforming to the dam, as built, comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Seepage and stability analyses. The soil engineering report indicates that the drain and the 10 foot berm were required for adequate safety against shear failure of the downstream slope. The reported stability analyses and design recommendations were based, however, on strength tests for the weakest

embankment material (ML) which was not supposed to be used in the major portion of the dam. Stability analyses for the dam, as constructed, are not available. This is considered a deficiency that should be corrected.

d. Validity. The available data and analyses conform with accepted practice at that time.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the 102 Rivers, C-5 Dam was made on May 14, 1979. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska, making the inspection were: Rey S. Decker, Geotechnical; Gordon Jamison, Hydrology; Garold Ulmer, Civil Engineer.

b. Dam.

(1) Geology and Soils (abutment and embankment). The dam is located in the northern Missouri loess-till area. The abutments consist of a thin mantle of loess underlain by dense glacial clay till (probably Kansan). The till formation is exposed near the water's edge on the right abutment. Plans show that soils in the dam consist of thin outside shell sections of CL-ML alluvial-colluvial materials derived from erosion of the loess-till hills with the principal portion of the dam constructed of CL-CH glacial till. Materials observed on the dam were plastic CL's.

(2) Upstream slope. The upstream slope is well vegetated with adapted grasses and legumes. Some minor erosion was noted along the downstream edge of the upstream berm as shown in Appendix B, Photo 5. No cracks, slumps or abnormal deformations were noted on the upstream face.

(3) Crest. The crest is well vegetated with adapted grasses and legumes. Measurements along the crest indicate that it is almost uniform in elevation and constructed according to the plans. Field measurements indicate a settling of approximately 1/2 foot at maximum section (approximately Sta. 5+50 - SCS plans). No cracks, sink holes, rodent holes or abnormal deformations were observed. There was no evidence of overtopping.

(4) Downstream slope. The downstream slope is well vegetated with brome and other adopted grasses. No cracks, slides or deformations were noted. A small seep area was observed in the right (looking downstream) abutment trough downstream from about Station 8+40 (plans). The seepage was clear and was not flowing. Seepage was also noted along both sides of the principal spillway stilling basin, about 5 to 5.5 feet above the invert elevation

of the outlet pipe. Seepage in the abutment trough and around the stilling basin appears to be outcropping at or near the contact of loess alluvium-colluvium and the underlying glacial till. All seepage effluent was clear and probably amounts to 0.1 gal./minute or less. Small slides and cat-steps in the natural soil banks adjacent to the upstream edge of the principal spillway stilling basin or scour hole would indicate some strength instability in these areas. This instability is probably due to the seepage outcrops and to undercutting of the banks when spillway discharges are high. No drainage outlets were observed.

(5) Miscellaneous. The apparent nature of materials in the major portion of the dam coupled with the luxuriant grass vegetation would indicate that minor overtopping would cause little damage to this structure.

c. Appurtenant Structures

(1) The principal spillway. There was no indication of spalling or deterioration of the concrete riser nor settlement and/or sag in the concrete pipe outlet and support structure. The lake level was at the elevation of the ports in the riser at the time of the inspection.

(2) The emergency spillway. The emergency spillway is well vegetated with adapted grasses. It looked very good with no evidence of erosion, slides, or other problems. A high-water line of debris would indicate that the spillway had never been in use. A fence is located across the spillway downstream from the control section and should not significantly affect its operation.

(3) Drawdown facilities. The plans show a 16 inch reinforced concrete pipe entering the base of the principal spillway riser. Flow through this system is controlled by a 16 inch rising stem slide gate. This system is designed as a drawdown facility to evacuate the lake. It is not known whether or not the gate is operable.

d. Reservoir Area. No wave wash, excessive erosion or slides were observed along the shore of the reservoir. Most of the shoreline is cropped with alfalfa and pasture down to the water's edge.

e. Downstream channel. The channel downstream from the principal spillway is open and traverses as well managed pasture.

3.2 EVALUATION

The dam and appurtenances look very good. The seepage in the right abutment trough and around the stilling basin are apparently outcropping on top of the nearly impervious glacial till. Seepage velocities are very low and the erosional resistance of the materials at and below the seepage outcrops appears to be moderately high which should minimize the danger of piping failures in this area. Instability of the slopes around the stilling basin of the principal spillway should not endanger the structural stability of the dam. Minor overtopping of the dam should not cause extensive damage or endanger the safety of the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam. The pool level is influenced by rainfall, seepage, evaporation, and the capacity of the uncontrolled spillways. Procedures for operating and drawdown facility are not known.

4.2 MAINTENANCE OF DAM

The dam and appurtenances are well maintained. It is reported by SCS personnel that the owners inspect their dams at regular intervals. The slight erosion along the upper edge of the upstream berm does not appear to be serious and could probably be corrected with new seedings of strawberry clover or other water-loving grasses.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam except for the 16 inch drawdown facility.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

There does not appear to be any serious potential of failure of this structure. However, seepage and stability analyses should be obtained as a matter of record.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Pertinent hydraulic and hydrologic data which were taken from as-built plans furnished by the SCS are tabulated in Appendix D on Hydrologic Computations.

b. Experience. The drainage area and lake surface area are developed from USGS Maryville Quadrangle and orthophoto sheets. The spillway and dam layout are from as-built plans and surveys made during inspection. There were no major discrepancies discovered as far as the hydraulic structural components of the dam and spillway were concerned.

c. Visual Observations.

(1) Principal and emergency spillways are in good condition.

(2) The emergency spillway does not appear to have ever been used.

(3) The emergency spillway and exit channel are in the left abutment away from the dam. Spillway releases will not endanger the integrity of the dam.

d. Overtopping Potential. The spillways are too small to pass the PMF and 1/2 the PMF without overtopping. The existing spillways will pass 35% of the PMF and the 100-year Frequency Flood without overtopping. Due to the nature of the materials in this dam and the excellent vegetative cover, minor overtopping should cause little damage to this dam. The results of the routings through the dam are tabulated in regards to the following conditions.

Frequency	Inflow Discharge c.f.s.	Outflow Discharge c.f.s.	Maximum Pool Elevation	Freeboard Top of Dam Min. Elev. 1065.1	Time Dam Overtopping Hr.
100 Yr.	4100	160	1060.2	+4.9	0
1/2 PMF	7700	6100	1066.2	-1.1	2+
PMF	15400	14300	1067.5	-2.4	5±
0.35 PMF	5400	2200	1065.1	0	0

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a nigh hazard rating and a small size. Therefore, the 1/2 PMF to PMF is the test for the adequacy of the dam and its spillways.

The estimated damage zone is described in Paragraph 1.2d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. Nothing was observed by the inspection team that would seriously affect the structural stability of this dam. Hydraulic/Hydrologic analyses presented in Section 5 indicate that the dam would be overtopped for periods of 2 to 5 hours by the 1/2 PMF and PMF storms. The nature of materials in this dam and the excellent vegetative cover indicate that overtopping of 2-5 hours would not endanger the structural stability of the dam.

b. Design and Construction Data. The engineering data, analyses and plans supplied by the SCS conform to accepted practice. However, the stability analyses for the downstream slope do not apply to the structure as it was designed and constructed (as discussed in Section 2). It is felt that the safety against shear failure is probably adequate for the structure, as built, but an applicable analysis should be performed.

There is no apparent reason to question the adequacy of construction supervision and quality control.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Operation Records. There are no appurtenant structures that require operational functions other than the drawdown facility.

d. Post Construction Changes. The inspection party is not aware of any post construction changes for this structure.

e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted in this area is not expected to cause structural failure of this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. There does not appear to be any serious potential of failure of this structure. Other than minor seepage in the right abutment trough and along both sides of the principal spillway basin, and some minor erosion on the upstream berm, no other deficiencies were observed.

b. Adequacy of Information. Stability analyses conforming to the structure, as built, and comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" are not available, which is considered a deficiency.

c. Urgency. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II. Phase II investigation is not considered necessary.

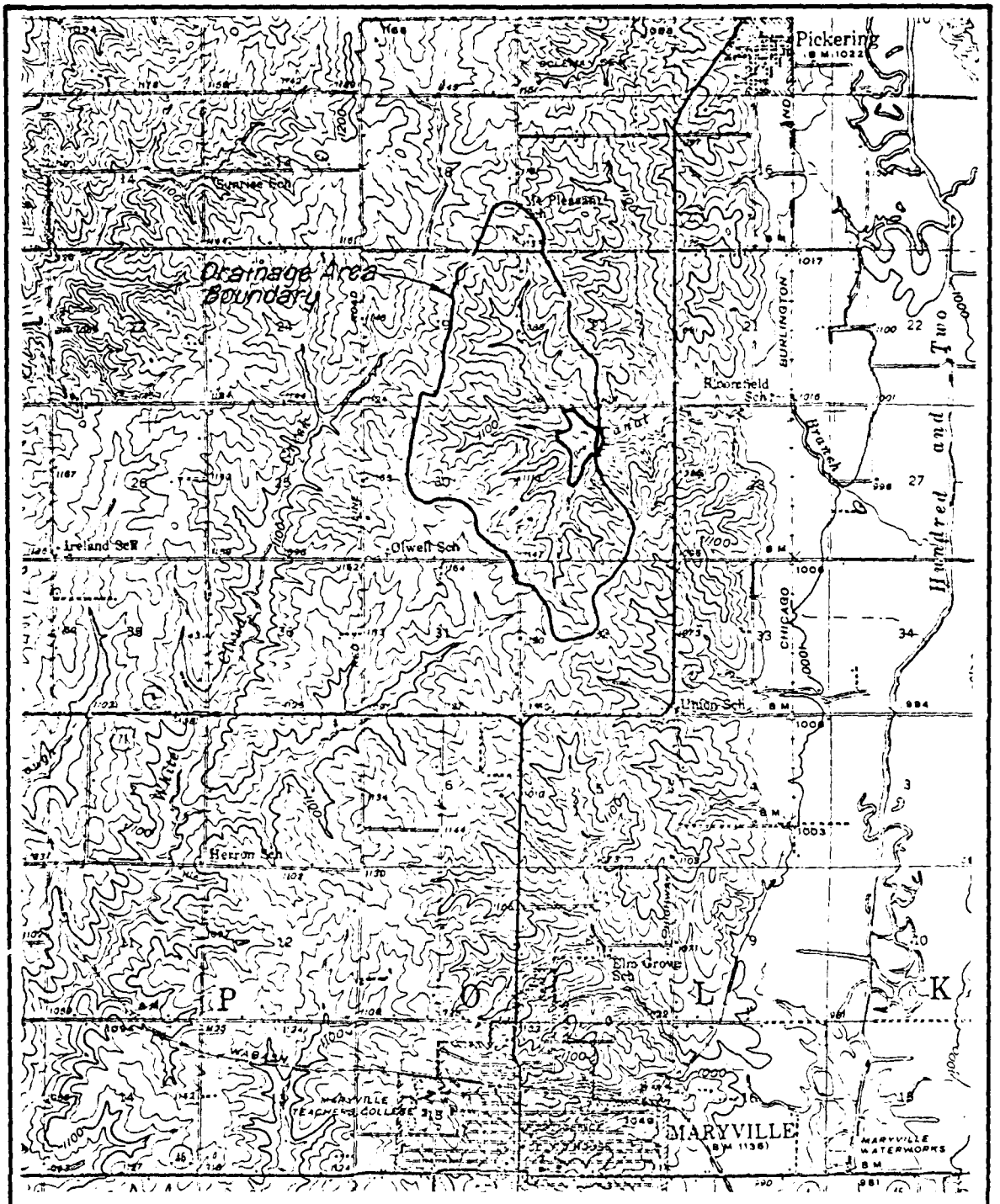
e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam. However, seepage and stability analyses should be performed for earthquake loadings and made a matter of record.

7.2 REMEDIAL MEASURES

a. Alternatives. Additional analyses should be obtained to evaluate the stability of the downstream slope from the standpoint of strength, seepage pressures and earthquake loadings. The size of emergency spillway and/or height of dam should be increased to pass 50% of PMF. The services of an engineer experienced in the design and construction of dams should be obtained to make these evaluations.

b. O & M Procedures. Maintenance of the structure is generally very good. Erosion along the downstream edge of the upstream berm should be evaluated on a periodic basis and repaired if it becomes serious.

APPENDIX A
MAPS



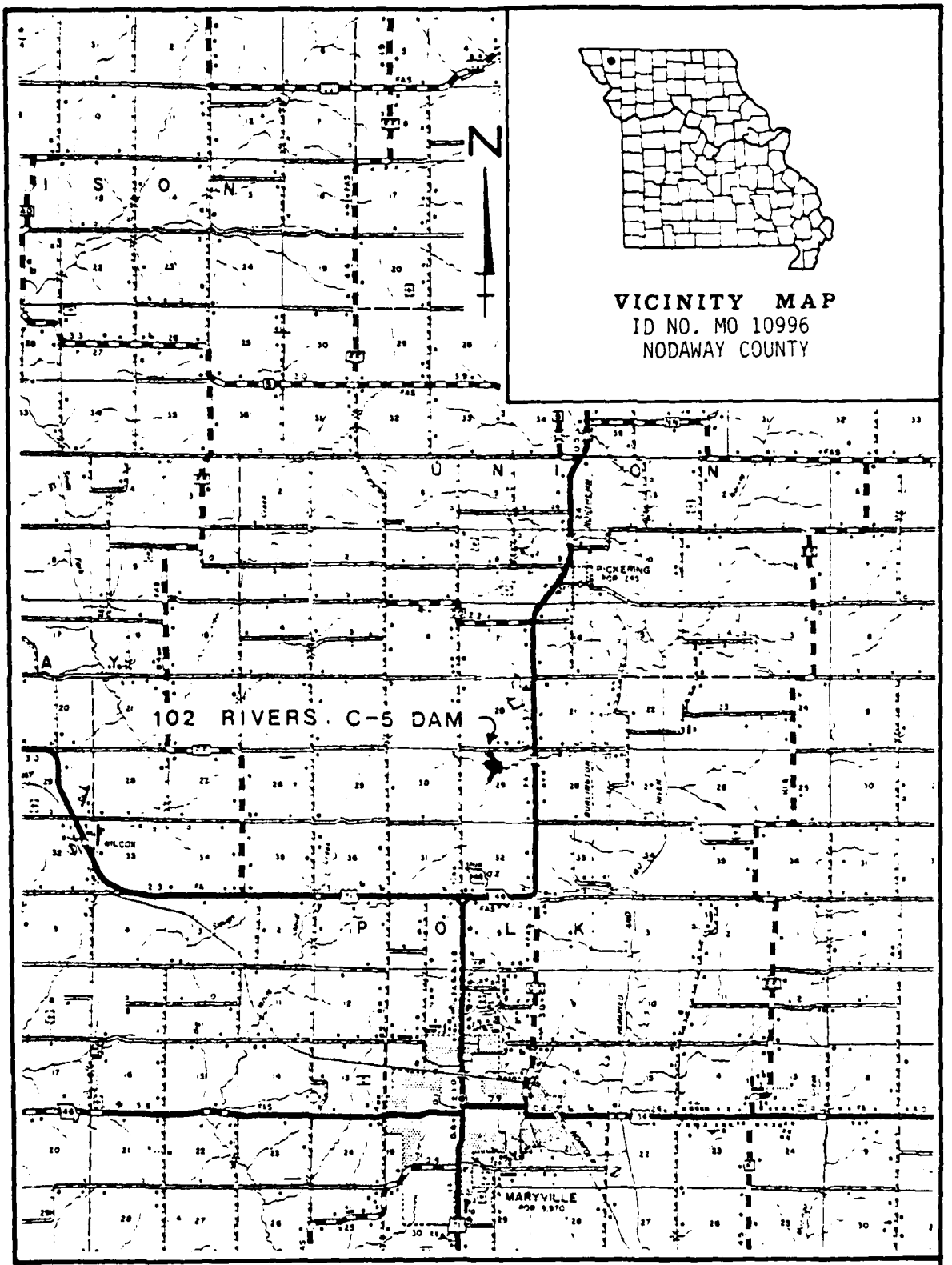
VICINITY TOPOGRAPHY

102 RIVERS, C-5 DAM

NODAWAY COUNTY, MISSOURI

MO. 10996

PLATE A-1



LOCATION MAP

PLATE A-2

APPENDIX B
PHOTOGRAPHS

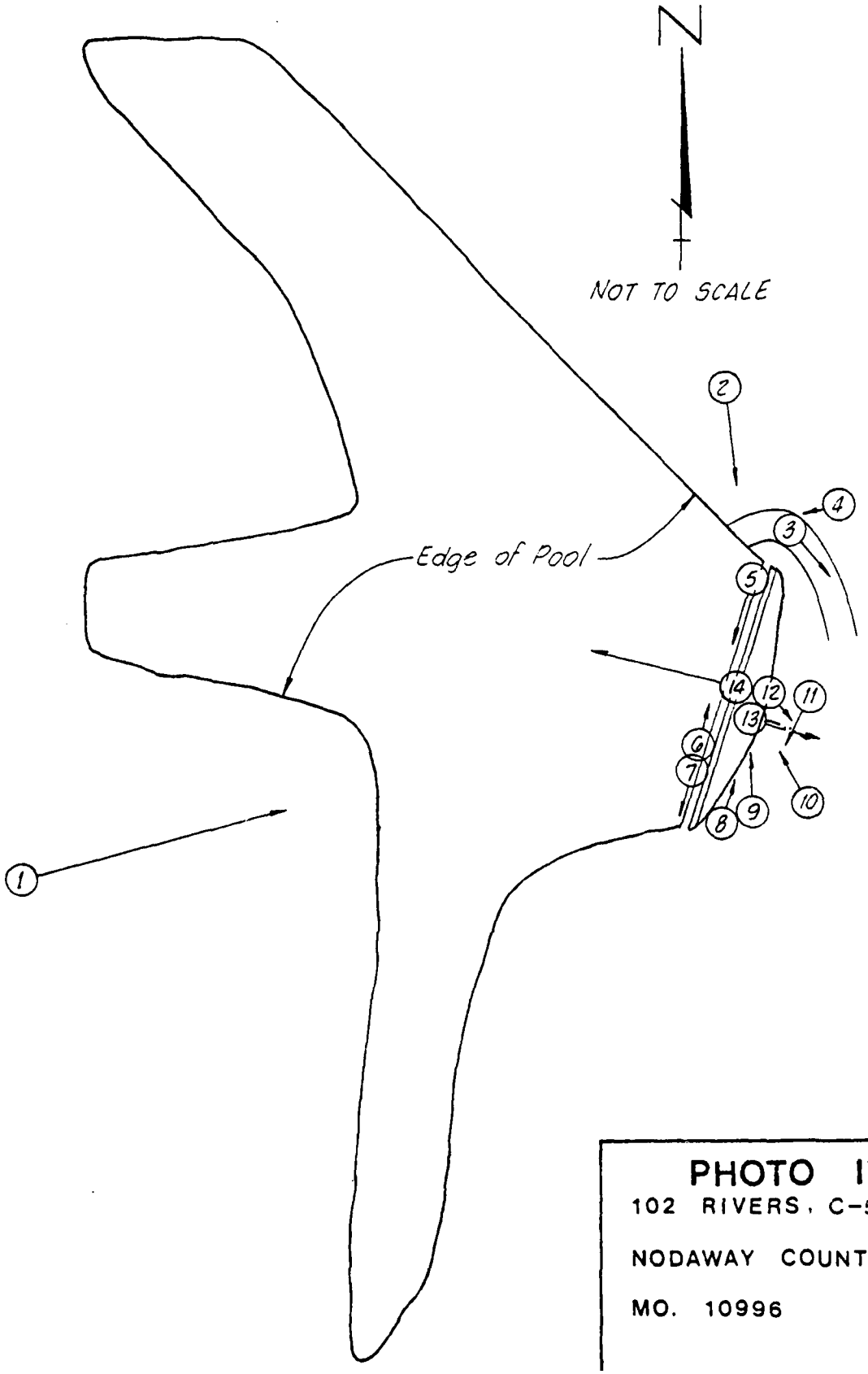


PHOTO INDEX

102 RIVERS, C-5 DAM

NODAWAY COUNTY, MISSOURI

MO. 10996

PLATE B-1

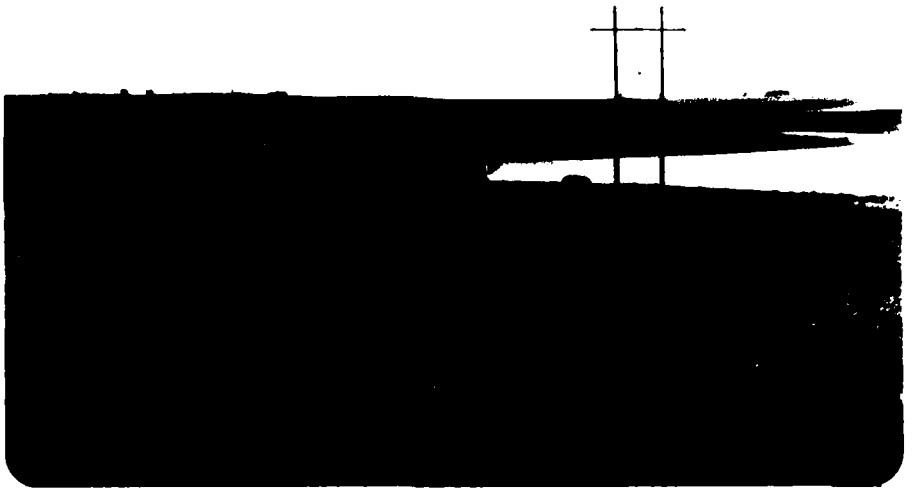


PHOTO NO. 2 - DAM FROM LEFT ABUTMENT. UPSTREAM END OF EMERGENCY SPILLWAY LOCATED AT RIGHT-CENTER OF PHOTO.

PHOTO NO. 3 - LOOKING DOWNSTREAM IN EMERGENCY SPILLWAY

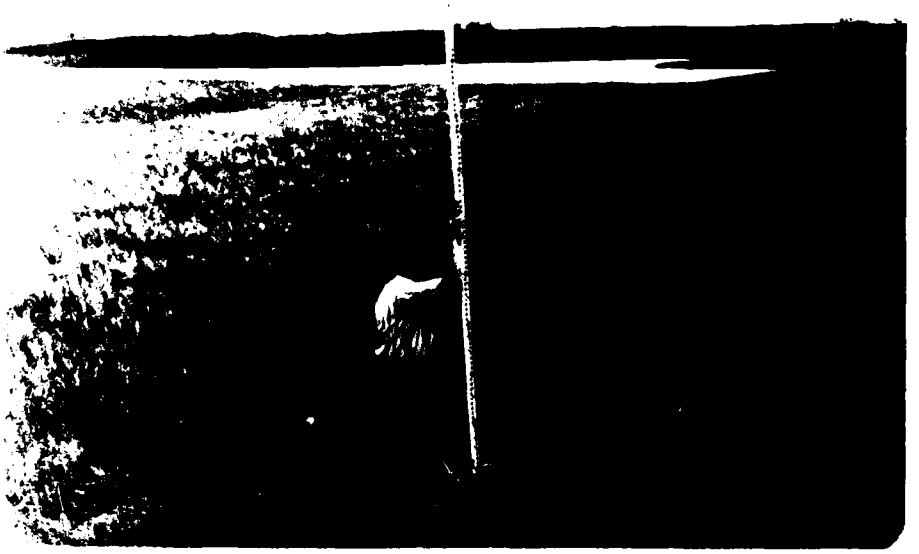


PHOTO NO. 4 - LOOKING UPSTREAM IN EMERGENCY SPILLWAY

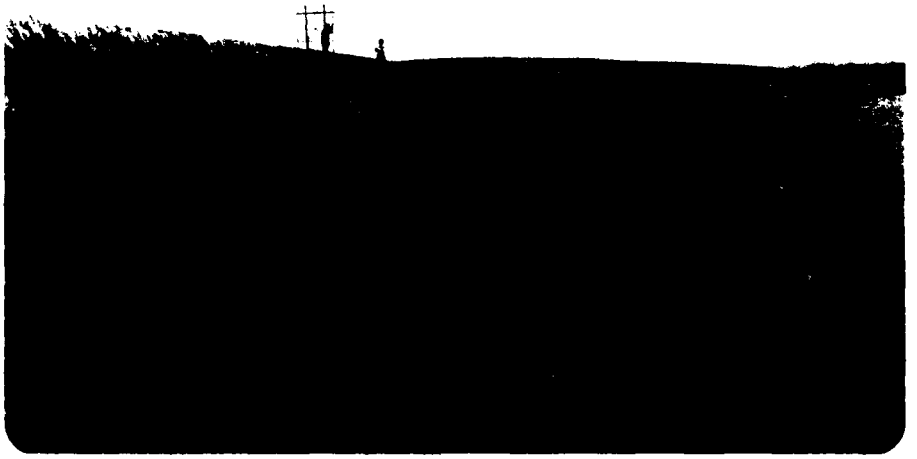


PHOTO NO. 5 - UPSTREAM SLOPE, BERM AND SPILLWAY RISER FROM LEFT SIDE

PHOTO NO. 6 - PORTS IN RIGHT SIDE OF RISER. WATER AT LEVEL OF PORTS

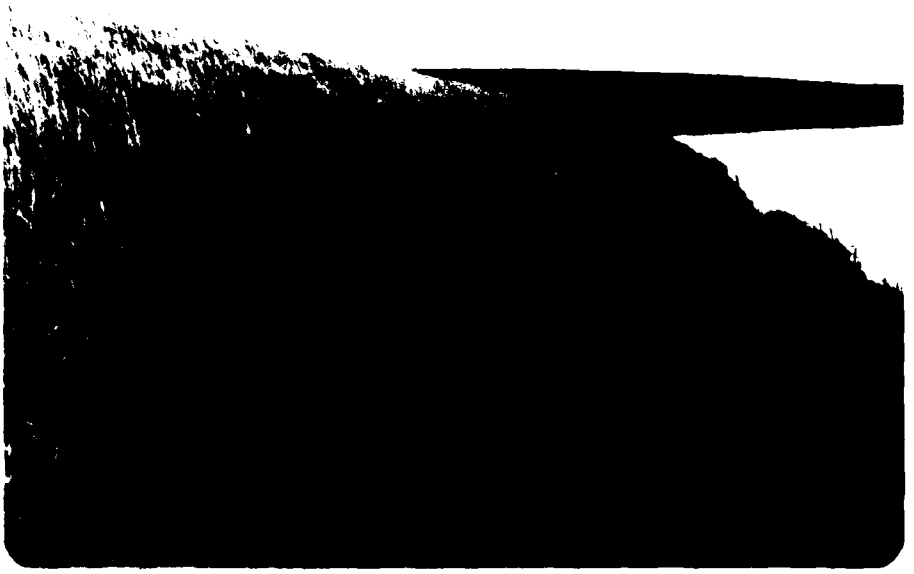


PHOTO NO. 7 - UPSTREAM SLOPE AND BERM

PHOTO NO. 8 - DOWNSTREAM SLOPE FROM RIGHT SIDE

PHOTO NO. 9 - SEEP OPPOSITE STA. 8 + 40 AT TOE

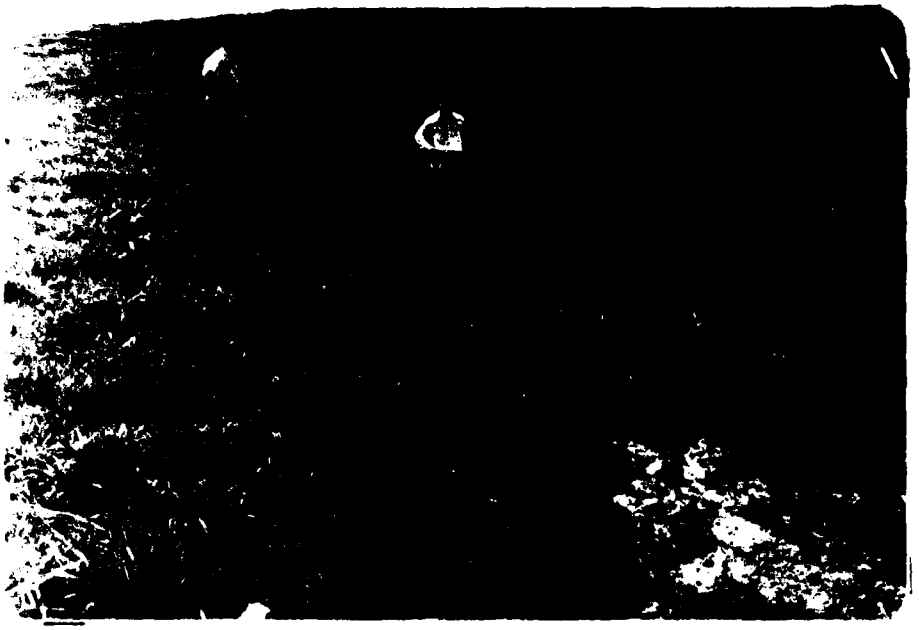


PHOTO NO. 10 - SEEP AREA TAKEN FROM RIGHT SIDE OF STILLING BASIN

PHOTO NO. 11 - OUTLET END OF PRINCIPAL SPILLWAY. SHOWING SEEPAGE AREA ON RIGHT SIDE OF STILLING BASIN

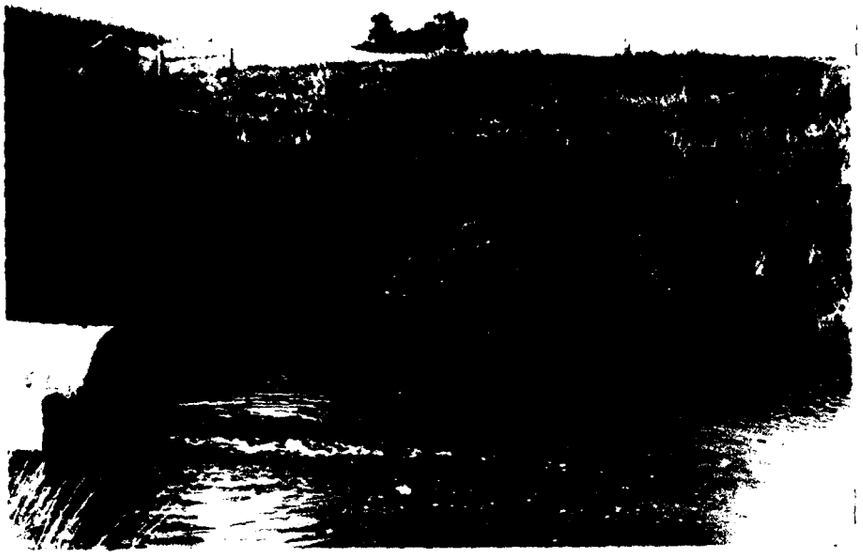


PHOTO NO. 12 - SEEP ON LEFT SIDE OF STILLING BASIN

PHOTO NO. 13 - DOWNSTREAM FROM CENTERLINE OF DAM

PHOTO NO. 14 - UPSTREAM FROM CENTERLINE OF DAM

APPENDIX C
PROJECT PLATES

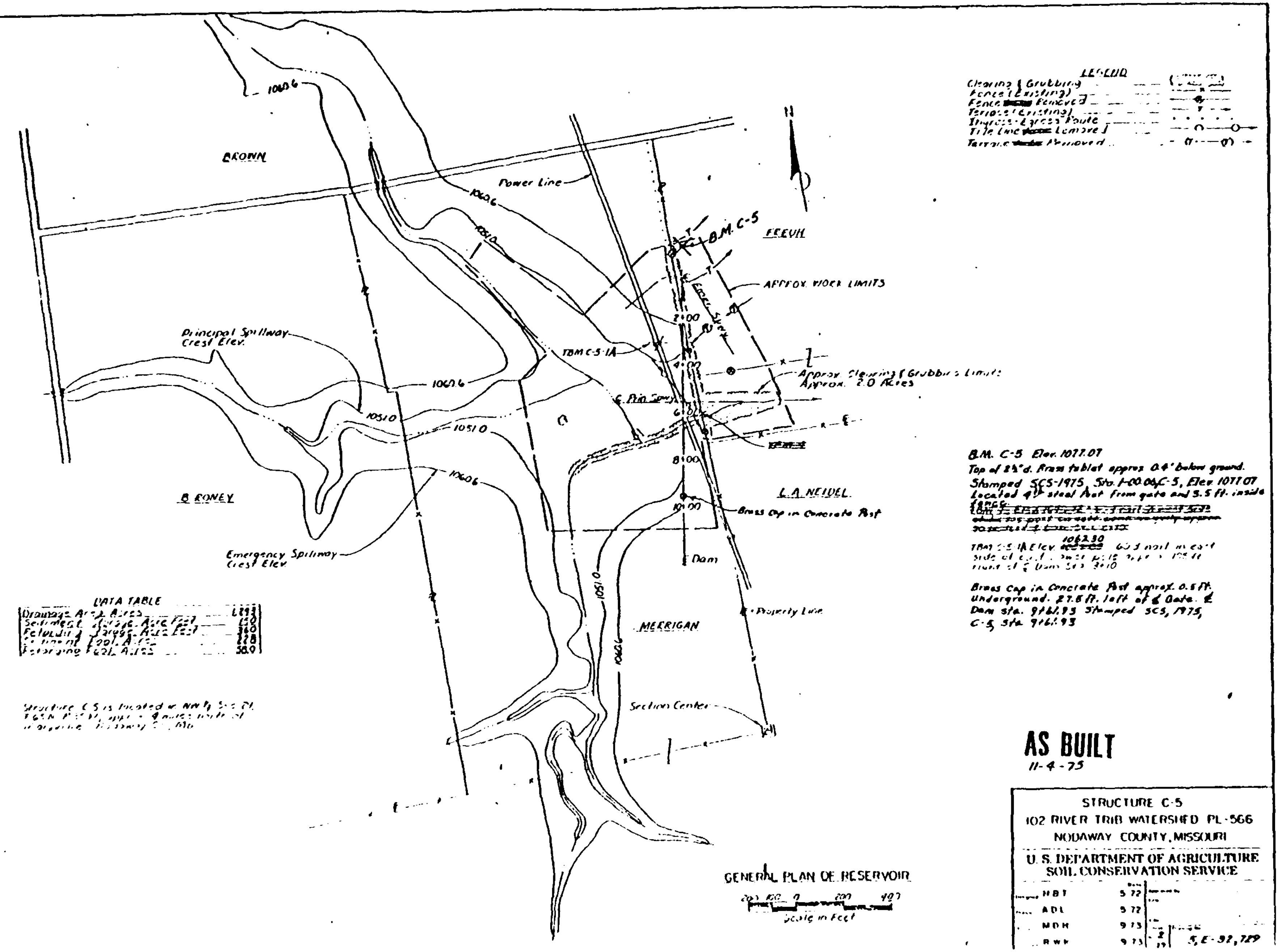

LEGEND
BROWN
Power Line
B.M. C-5
FREVH
APPROX. WORK LIMITS
Principal Spillway Crest Elev.
TBM C-5-1A
Approx. Clearing & Grubbing Limits Approx. 2.0 Acres
B RONEY
L.A. NEIDEL
Brass Cap in Concrete Post
Emergency Spillway Crest Elev.
Dam
DATA TABLE
MERRIGAN
Property Line
Section Center
1060.6
1051.0
B.M. C-5 Elev. 1077.07
Top of 3½" d. Brass tablet approx. 0.4' below ground.
Stamped SCS-1975, Sta. 1+00.06 C-5, Elev. 1077.07
Brass Cap in Concrete Post approx. 0.5 ft. Underground. 27.8 ft. left of ℄ Gate. ℄ Dam Sta. 9+61.93 Stamped SCS, 1975, C-5, Sta. 9+61.93
AS BUILT
11-4-75
STRUCTURE C-5
102 RIVER TRIB WATERSHED PL-566
NODAWAY COUNTY, MISSOURI
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
GENERAL PLAN OF RESERVOIR
Scale in Feet

PLATE C-1

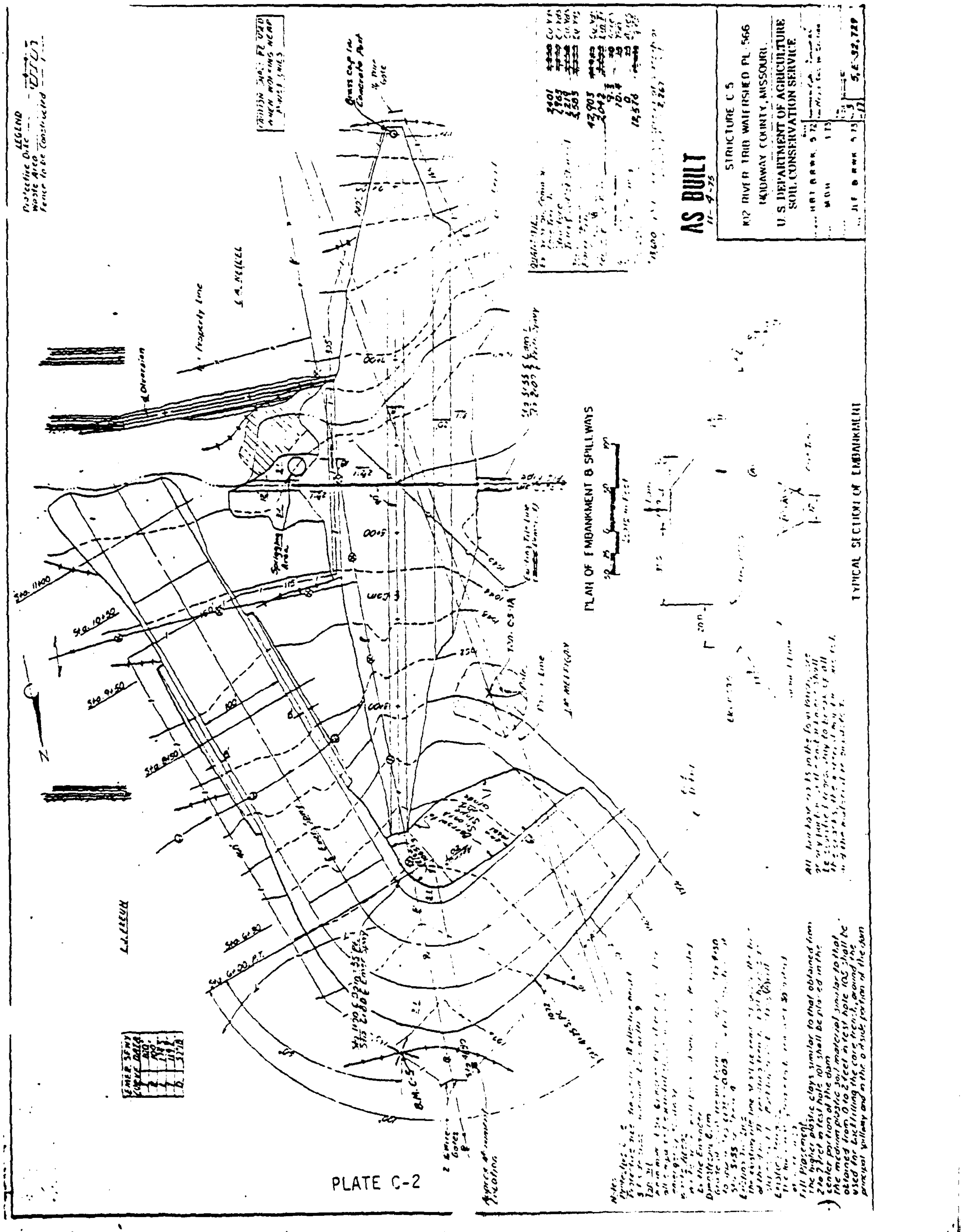
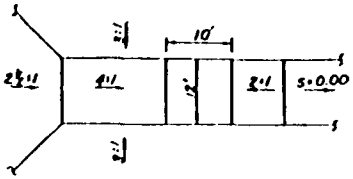

AS BUILT
11-4-75
STRUCTURE C 5
102 RIVER TRIB WATERSHED PL 566
NODAWAY COUNTY, MISSOURI
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
PLAN OF EMBANKMENT & SPILLWAYS
TYPICAL SECTION OF EMBANKMENT
LEGEND
Property Line
Diversion
Sta. 11+00
Sta. 10+50
Sta. 9+50
Sta. 8+50
B.M. C-5

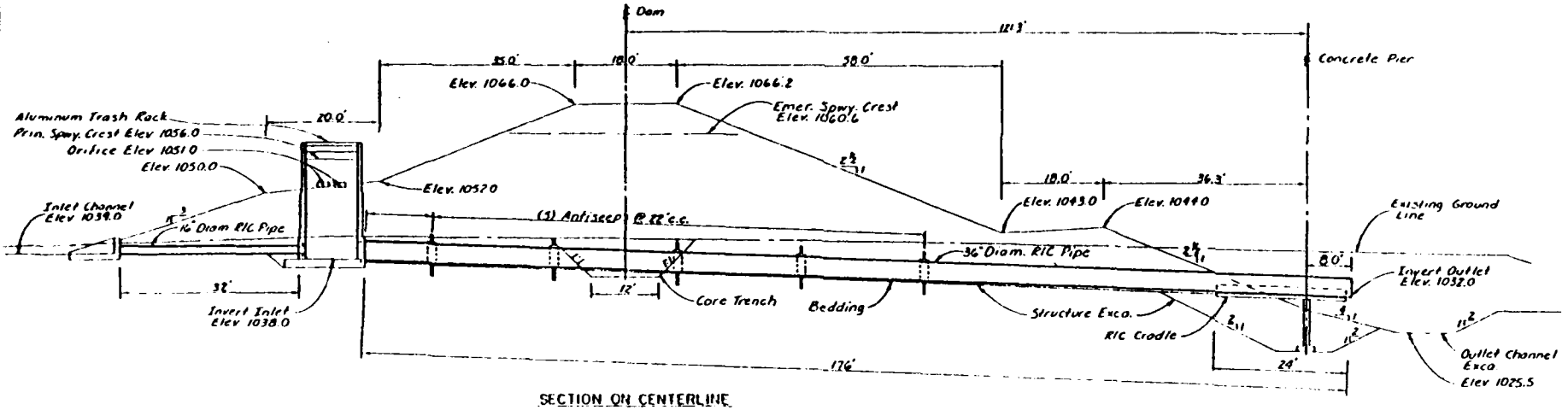
PLATE C-2

CAMBER TABLE	
Dist. From Outlet	Elev.
0	1032.00
8	1032.27
16	1032.53
24	1032.80
32	1033.07
40	1033.34
48	1033.61
56	1033.87
64	1034.14
72	1034.41
80	1034.68
88	1035.12
96	1035.55
104	1035.99
112	1036.43
120	1036.86
128	1037.30
136	1037.74
144	1038.17
152	1038.61
160	1039.05
168	1039.48
176	1039.92

Notes:
1. Antiseeps shall not be placed closer than two (2) feet to a pipe joint.
2. Camber conduit in accordance with the elevations shown.
3. Conduit elevations other than those shown will be furnished by the Engineer, when required.



PARTIAL PLAN - STILLING BASIN



SECTION ON CENTERLINE

10 5 0 10 20
Scale in Feet

AS BUILT
COMPLETION DATE: NOV 6 1973

MATERIALS

Concrete, Class 4000	66.6 Cu. Yds.
Steel Bar Reinforcement	7310 Pounds
Reinforced Concrete Pressure Pipe, 36" Diam., Steel Ring Type Joint & Rubber Gasket	176 Lin. Ft.
Reinforced Concrete Pressure Pipe, 16" Diam., Steel Ring Type Joint & Rubber Gasket	32 Lin. Ft.
Aluminum Trash Racks	Lump Sum
Slide Gate, 16" Diam	1 Each

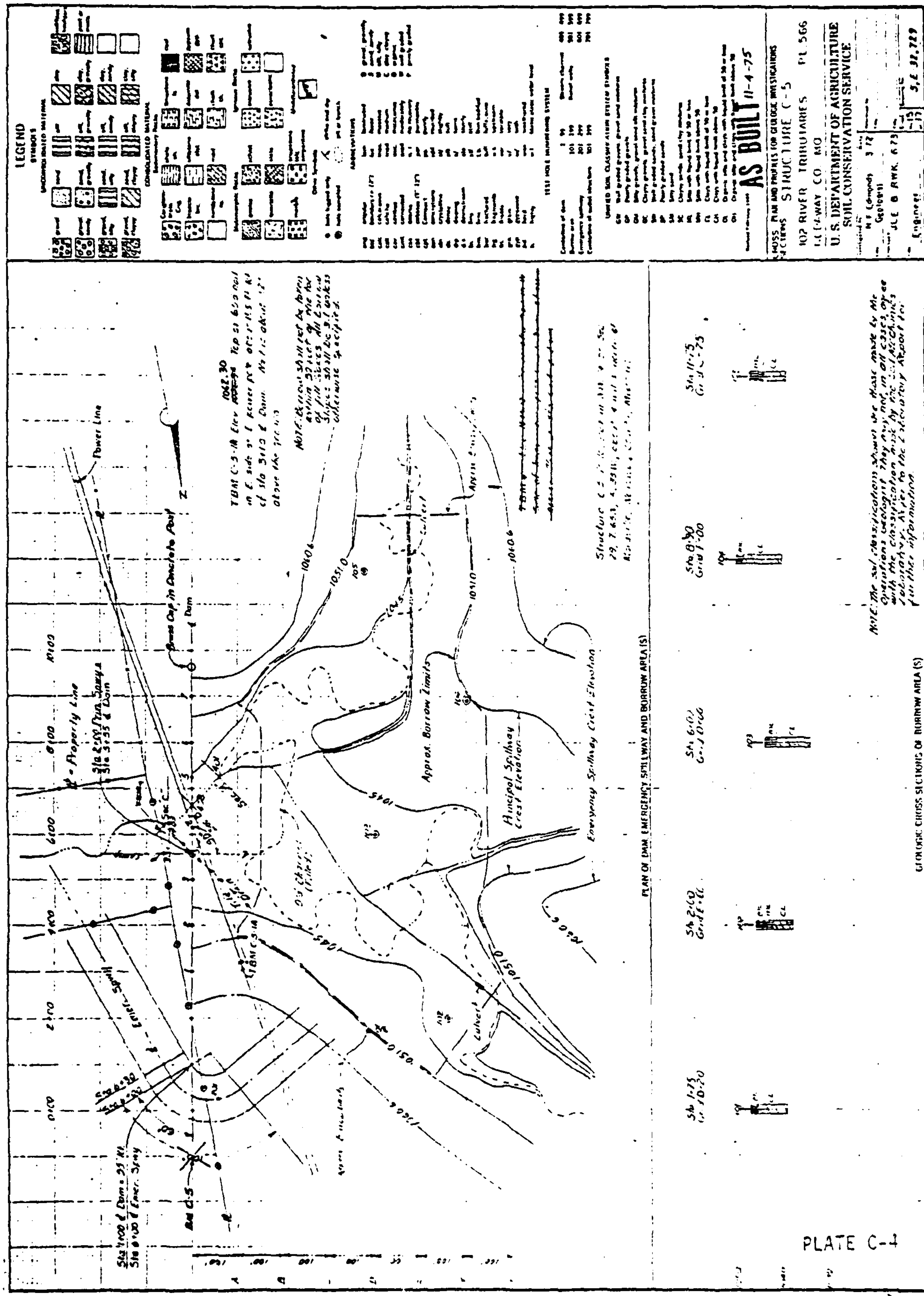
STRUCTURE C-5

R/C DROP INLET FOR 36" DIAM PIPE
GENERAL LAYOUT
102 RIVER TRIB WATERSHED PL-566
NODAWAY COUNTY, MISSOURI

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
RWK, BBES		9-72
MDH		9-73

PLATE C-3



LEGEND
AS BUILT 11-4-75
STRUCTURE C-5
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
PLAN OF DAM EMERGENCY SPILLWAY AND BORROW AREA (S)
GEOLOGIC CROSS SECTIONS OF BORROW AREA (S)
Power Line
Property Line
Approx. Borrow Limits
Principal Spillway Crest Elevation
Emergency Spillway Crest Elevation

PLATE C-4

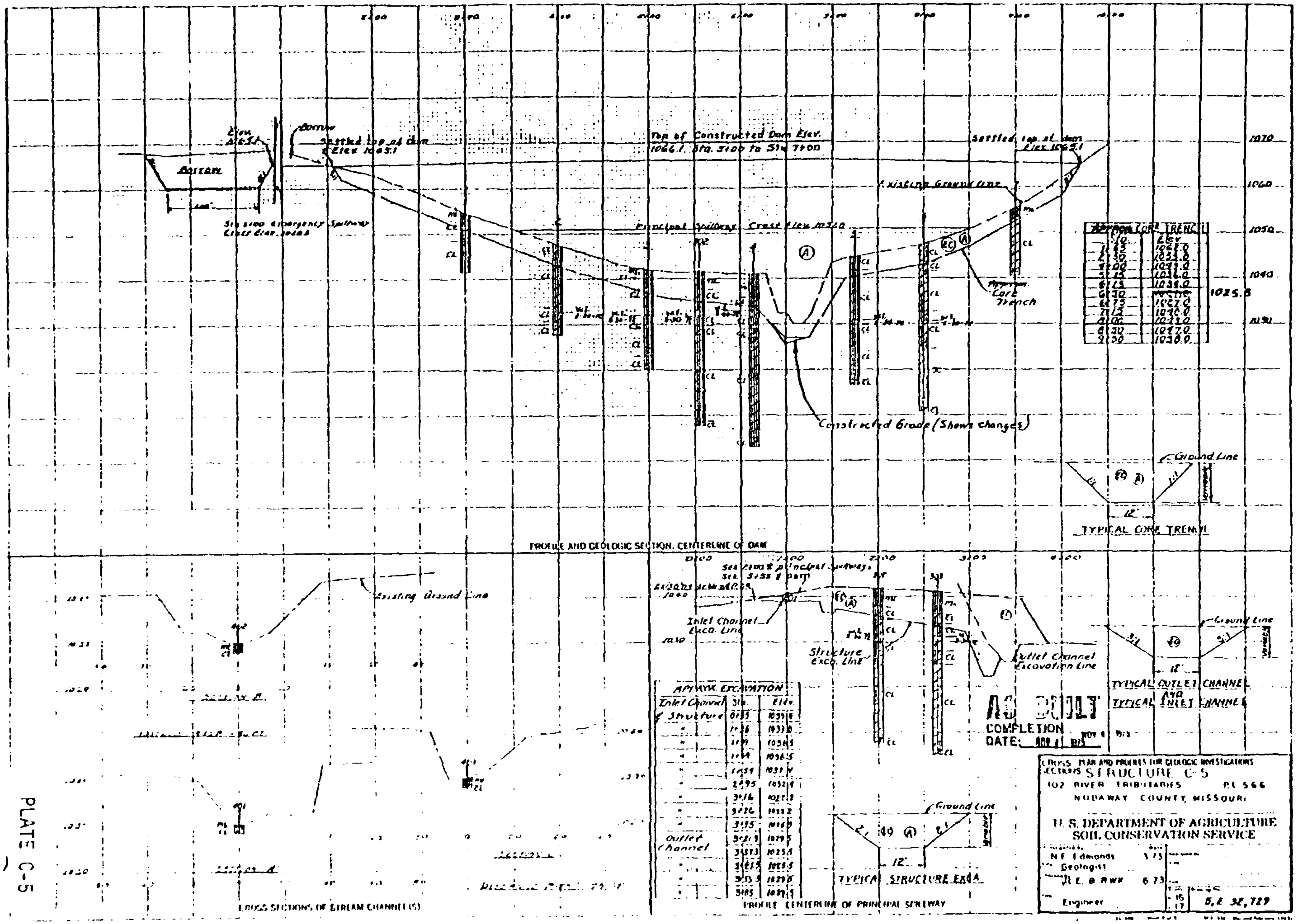

Top of Constructed Dam Elev. 1066.1 Sta. 5100 to Sta. 7100
Settled top of dam Elev. 1065.1
Borrow
Existing Ground Line
Principal Spillway Crest Elev. 1052.0
Constructed Grade (Shows changes)
Approx. Core Trench
TYPICAL CORE TRENCH
Ground Line
PROFILE AND GEOLOGIC SECTION, CENTERLINE OF DAM
Existing Ground Line
Inlet Channel Exca. Line
Structure Exca. Line
Outlet Channel Excavation Line
TYPICAL OUTLET CHANNEL AND TYPICAL INLET CHANNEL
TYPICAL STRUCTURE EXCA.
APPROX. EXCAVATION
Inlet Channel
Structure
Outlet Channel
AS BUILT
COMPLETION DATE:
CROSS SECTIONS OF STREAM CHANNEL(S)
PROFILE CENTERLINE OF PRINCIPAL SPILLWAY
CROSS SECTIONS PLAN AND PROFILES FOR GEOLOGIC INVESTIGATIONS
STRUCTURE C-5
102 RIVER TRIBUTARIES P.L. 566
NODAWAY COUNTY, MISSOURI
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
N.E. Edmonds
Geologist
Engineer
5-E 32,729

PLATE C-5

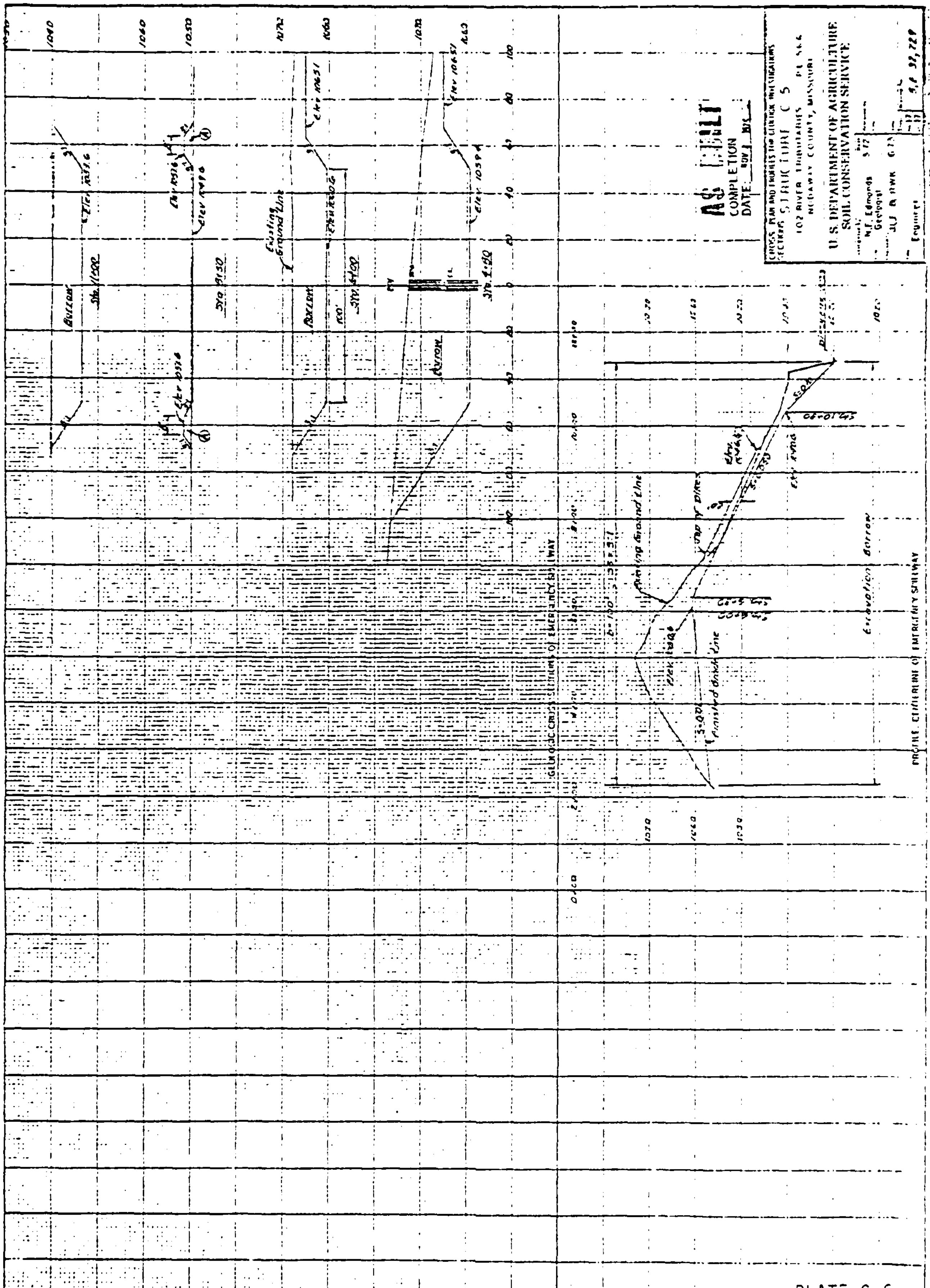

AS BUILT
COMPLETION
DATE NOV 1 1975
CROSS SECTIONS PLAN AND PROFILES FOR GEOLOGIC INVESTIGATIONS
STRUCTURE C 5
102 RIVER TRIBUTARIES
NODAWAY COUNTY, MISSOURI
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
N.F. Edmonds
Geologist
Engineer
GEOLOGIC CROSS SECTION OF EMERGENCY SPILLWAY
PROFILE CENTERLINE OF EMERGENCY SPILLWAY
Existing Ground Line
Finished ditch line
Excavation Bottom

PLATE C-6

STRUCTURE DATA

Class of Structure "b" Flood Retarding

Drainage Area (total) 1,293 Ac. 2.02 Sq.Mi.

(uncontrolled) 1,293 Ac. 2.02 Sq.Mi.

Time of Concentration 0.79 Hours

Soil Cover Complex Number 77 For A.M.C. II

Sediment Capacity Available 150.0 Ac.Ft. below Elev. 1051.0

Total Sediment Capacity Available 150.0 Ac.Ft.

Capacity Equivalents (Vol.) 1.39 In.

[illegible] 360.0 Ac.Ft.

[illegible] Equivalents (Vol.) 3.34

[illegible] None Ac.Ft.-[illegible]

[illegible]

[illegible] 41

[illegible] 165

[illegible] 1051.0

[illegible]

[illegible] 2 Storm [illegible] 6 Hour

[illegible] Vegetated Earth [illegible] 0.04

[illegible] Class b [illegible]

Rainfall 7.92 in.

Runoff 5.20 in.

Peak Inflow 3,421 c.f.s.

Maximum Discharge - Emergency Spillway 354 c.f.s.

Max. of Water Surface Elev. 1062.1

Velocity of Flow (Ve) 5.9 [illegible]

Supplementary Data and Special Design Feat.

Orifice Elev. = 1051.0
Principal Spillway Crest Elev. = 1056.0
Emergency Spillway Crest Elev. = 1060.6
Emergency Spillway Bottom Width = 100'
Settled Top of Dam Elev. = 1065.1
Height x Storage = 30.6 x 510 = 15,606

Freeboard Hydrograph for Class b Structures

Rainfall 13.68 in.

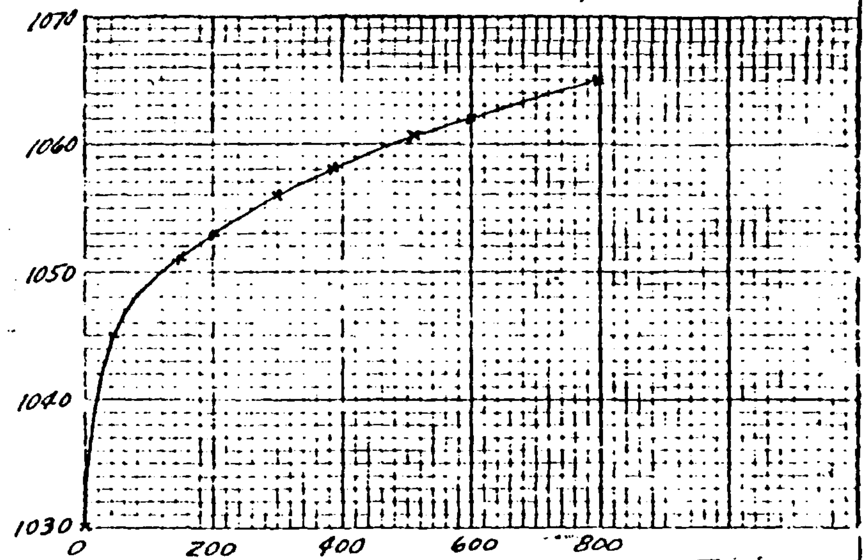
Runoff 10.65 in.

Peak Inflow 7,246 c.f.s.

Maximum Discharge - Emergency Spillway 2,254 c.f.s.

Maximum Water Surface Elev. 1065.0

Reservoir Capacity



[illegible] Storage - Ac.Ft.

AS BUILT
11-4-75

[illegible]

STRUCTURE C-5
102 RIVER TRIB. WATERSHED P.L.566
NODAWAY COUNTY, MISSOURI
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

BES & RWK 9-72
BES 9-72
RWK 12-72
5, [illegible] 32,729-H

PLATE C-7

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE - Soil Mechanics Laboratory
800 "J" Street, Lincoln, Nebraska 68508

Edmonds MF
Keewis RWC
Blaine MMB
File 13-18
G

SUBJECT: ENG 22-5, Missouri WF-08, 102 River Tributaries
Site No. C-5 (Nodaway County)

DATE: August 11, 1972

TO: James M. Dale, State Conservation Engineer
SCS, Columbia, Missouri

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Data, 2 sheets.
2. Form SCS-ENG-128 & 128A, Consolidation Test Data, 1 test, 5 sheets.
3. Form SCS-127, Soil Permeability, 1 sheet.
4. Form SCS-355A, Triaxial Shear Test Data, 2 tests, 2 sheets.
5. Form SCS-352, Compaction and Penetration Resistance, 6 sheets.
6. Form SCS-357, Summary - Slope Stability Analysis, 2 sheets.
7. Form RTSC-FW-ENG-42, Determination of s and Probable Joint Gaps, 1 sheet.

INTRODUCTION

The proposed 35-foot high, class "b" hazard embankment is located in the Iowa and Missouri Heavy Till Plain physiographic area in Nodaway County in the northwest corner of Missouri.

The major engineering problems at this site are a deep compressible alluvial foundation, borrow materials susceptible to drying cracks, and rather weak embankment materials at 95% of Standard Proctor density.

DISCUSSION

FOUNDATION

A. Classification. The flood plain has high-plasticity CL and CH alluvial deposits up to 35 feet deep over dense, stiff Kansan till. The alluvial foundation samples submitted are CL and CH materials. The CL materials have liquid limits ranging from 43 to 49 and plasticity indices varying from 19 to 31. The CH sample had a liquid limit of 51 and a plasticity index of 28. Dispersion was generally low for all the foundation samples except the undisturbed sample 302.3 (72W2239) which had a dispersion of 71%.

Some sandy clay was encountered from 23 feet to 36 feet on the right side of the flood plain.

The abutments consist of stiff, high-plasticity Kansan till.

B. Dry Unit Weight. The Shelby tube sample 302.3 (72W2239) yielded CL test specimens with dry densities varying from 1.39 gm/cc (86.7 pcf)

PLATE C-8

to 1.48 gm/cc (92.4 pcf). Standard penetration tests in the material represented by Sample 302.3 (72W2239) yielded blow count of 8 blows per foot in saturated material. Blow Counts of 6 blows per foot were obtained in 2 tests in the alluvium underlying the above sample.

C. Consolidation. A one-dimensional consolidation test was made on the CL Shelby tube sample 302.3 (72W2239). The 1" x 2.5" test specimen was saturated at the start of the test and loaded to 32 ksf. The void ratio versus pressure curve plotted from the test data indicates the material is somewhat preconsolidated to the present overburden load. The indicated preconsolidation load is in the range of 3000 to 7000 psf. The virgin curve is not sharply defined by the void ratio versus pressure plot, so the test data can be interpreted over a fairly wide range. A preconsolidation load of 3500 psf appears to be a reasonably conservative value. The proposed 24-foot high embankment and overburden load will be approximately 3500 psf, so the consolidation potential of the foundation should be fairly low. The consolidation potential for a 3500 psf load from the percent consolidation curve for the test data is approximately 4.5%. For a corrected field curve a consolidation potential of approximately 2% is obtained for the 3500 psf load. An average consolidation potential of 2% for the 30 feet of alluvium under the 24-foot high embankment at Station 5+55 appears to be a reasonable value for this site.

The rate of consolidation of the alluvium will be quite slow due to the low permeability and the long seepage path. Consider all foundation consolidation as residual at the time construction is complete.

D. Permeability. A falling head permeability test was made on the CL consolidation test specimen. The permeability curve was extrapolated to obtain an initial vertical permeability rate of approximately 0.00035 fpd.

E. Shear Strength. A consolidated undrained triaxial shear test was made on the CL core sample 302.3 (72W2239). The 1.4-inch diameter test specimens were trimmed from the Shelby tube sample and then back-pressured on the shear machine to full saturation.

The test data was interpreted to give total stress shear parameters of $\phi = 13°$ and $c = 525$ psf.

EMBANKMENT

A. Classification. The 6 samples of borrow materials submitted to the Soil Mechanics Laboratory varied from moderately plastic ML to high plasticity CL. The 2 ML samples had liquid limits of 40 and 41 and plasticity indices of 14 and 15. The 4 CL samples had liquid limits varying from 39 to 47 and plasticity indices from 23 to 31.

Low dispersion values were obtained for all of the borrow samples submitted.

The Atterberg limits indicate the CL materials will have shrinkage limits in the range of 11% to 16% and the ML materials will have shrinkage limits of approximately 21%.

B. Compacted Dry Density. Standard Proctor compaction tests (ASTM D-698, Method A) were made on the minus No. 4 fraction of all 6 of the borrow samples submitted. The 2 ML samples had maximum dry densities of 93.5 pcf and 96.5 pcf with respective optimum moisture contents of 23.5% and 22.0%. The maximum dry densities of the 4 CL samples varied from 99.5 pcf to 108.0 pcf and optimum moisture contents varied from 17.5% to 21%.

C. Shear Strength. A consolidated undrained triaxial shear test was made on the ML sample 103.2 (72W2246). The 1.4-inch diameter test specimens were molded slightly wet of optimum to a density of 95% of Standard Proctor. The test specimens were backpressured in the shear machine to full saturation prior to testing.

The test data was interpreted to yield total stress shear parameters of $\phi = 17.5°$ and $c = 275$ psf. The more plastic CL materials at 95% of Standard Proctor density are expected to be stronger than the ML that was tested.

D. Consolidation. Average embankment consolidation is estimated at 1.5% for the flood plain section.

STABILITY ANALYSIS

The proposed 35-foot high, class "b" hazard dam was analyzed using the ICES stability program and the IBM 360 computer. Shear parameters of $\phi = 17.5°$ and $c = 275$ psf were used to represent the embankment. The foundation shear parameters were $\phi = 13°$ and $c = 525$ psf.

A full drawdown analysis of the $2\frac{1}{2}$:1 upstream slope shows that a 3:1 slope is required below the 10-foot berm at elevation 1051.0 to obtain a safety factor of 1.41, which is considered adequate for the proposed class "b" hazard structure.

A steady seepage analysis of the downstream slope with a phreatic line developed from the emergency spillway elevation and a foundation drain at $c/b = 0.6$ shows a 10-foot berm is needed at elevation 1043.0 to obtain a safety factor of 1.44, which is considered adequate for this structure.

SETTLEMENT ANALYSIS

Average foundation settlement under the 24-foot high flood plain section is expected to be approximately 2%, and average embankment settlement is expected to be approximately 1.5%. Total settlement will be approximately one foot across the flood plain and should be considered as residual settlement at the completion of construction, due to the low permeabilities of the materials and the long seepage paths.

RECOMMENDATIONS

A. Site Preparation: Removal of the tile drain pipe at the site is recommended.

B. Centerline Cutoff. The shallow 5 to 6-foot deep cutoff, as proposed in the engineer's report, is considered satisfactory. A normal bottom width (10 to 12 feet) and 1:1 side slopes are considered adequate. Backfill with ML materials to reduce the hazard of drying cracks. Place at or near optimum and compact to a minimum density of 95% of Standard Proctor.

C. Principal Spillway. Base spreading of the embankment due to the deep (30 to 35 feet) compressible alluvium may present a pipe elongation problem at this site. Pipe elongation calculations using a 2% consolidation potential for 30 feet of compressible foundation show a horizontal strain of approximately 0.008 ft/ft for the proposed embankment. See the attached Form RTSC-FW-ENG-42 for calculations.

The deeper high-plasticity CL and CH materials will be subject to cracking upon drying, so special attention should be given to scarifying and backfilling if the principal spillway trench is cut through the ML surface layer, which will be less susceptible to drying cracks.

D. Drainage. A shallow foundation trench drain is required at c/b = 0.6 to draw the phreatic line down to provide embankment stability. Any well graded sand and gravel that meets the requirements of Soil Mechanics Note No. 1 will be adequate in the high-plasticity alluvium, which generally will have a high resistance to piping.

E. Embankment Design. The following are recommended:

1. Selectively place the high-plasticity CL materials in the center section with moisture contents at or below optimum. Scarify lifts that have dried out very carefully to break up any shrinkage cracks that may develop.

2. Selectively place the silty, lower plasticity ML materials on the outer shells to reduce the shrink-swell problems.

3. Compact all embankment materials to a minimum density of 95% of Standard Proctor (ASTM D-698, Method A).

4. Provide 2½:1 slopes above the upstream berm at elevation 1051 20' sloping berm and 3:1 slopes below the berm.

5. Provide 2½:1 downstream slopes with a 10-foot berm at elevation 1043.0.

6. Provide an overfill of one foot across the flood plain to compensate for residual foundation and embankment consolidation.

Prepared by:

Edgar F. Steele

Reviewed and Approved by:

Lorn P. Dunnigan
Head
Soil Mechanics Laboratory

Attachments

cc:
Project Office, Maysville, Mo. (2)
Kenneth M. Kent, Lincoln, Nebr.

SCS-ENG-354 | Ht. - 35.1' | Class b
Rev. 3-70 | 38,000 cu yds | FMR
File Code ENG-11-18

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

MISSOURI

102 River Tributaries #C-5

Lab. sample no.	Field no.	Location and description	Depth	Field classification	Fines	Sand	Gravel	LL	PI	Unified classification	Soluble salts %	Dispersion %	Moisture-density	Undisturbed sample data	Gs	Special tests
7.4																MEIS
2237	102.1	℄ Dam 5155 Jar	2-3'	ML	[illegible]	[illegible]	[illegible]									
2238	102.2	℄ Dam 5155 Jar	6-7'	CL	[illegible]	[illegible]	[illegible]									
2239	102.3	℄ Dam 5155 Undist	10-11'	CL	27 35 67 93 100			45	24	CL		71	[illegible]	1.05 [illegible]	[illegible]	✓ ✓
2240	102.4	℄ Dam 5155 Jar	16-17'	CL	29 37 66 100			51	28	CH		19				
2241	102.5	℄ Dam 5155 Jar	21-22'	CL	28 46 62 95 100			45	21	CL		31				
2242	102.6	℄ Dam 5155 Jar	26-27'	CL	28 39 62 85 100			43	19	CL		38				
2243	101.1	Borrow D120 1175 L. Bag	0-1.5'	ML	12 27 26 92 [illegible]	100						14				
2244	101.2	Borrow D120 1175 L. Bag	2-7	CL	9 24 27 92 [illegible]	100		47	[illegible]	CL		11	[illegible]		[illegible]	
2245	103.1	Borrow D100 6100 L. Bag	0-2	ML	8 [illegible]			[illegible]	[illegible]	CL		7	[illegible]		[illegible]	

5-30-71

SCS-ENG-354
Rev. 3-70
File Code ENG-13-10

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA

MISSOURI

Laboratory Sample Number	Field Number	Location and Description	Depth	Field Classification	Fines .002	Fines .005	Fines .02	Fines .05	Fines #200 .074	Sand #140 .105	Sand #60 .250	Sand #40 .42	Sand #20 .84	Sand #10 2.0	Sand #4 4.76	Gravel 3/8"	Gravel 1/2"	Gravel 3/4"	Gravel 1"	Gravel 1 1/2"	Gravel 3"	Atterberg Limits LL	Atterberg Limits PI	Unified Classification	Soluble Salts	Dispersion %	Moisture-Density Curve No.	Max γ_d pcf	w_o %	Undisturbed γ_d g/cc	Undisturbed w_o %	G_s	Special Tests
72N		102 River Tributaries C-5																															MC
2246	103.3	Borrow D100 6100 L. Bag	3-9	CL	24	32	58	93	96					100								41	15	ML		7	(3)	103.5	18.5		/	2.57	✓
2247	104.2	Borrow F100 8100 L. Bag	2-8	CL	29	34	49	49	73					100								37	22	CL		8	(4)	108.0	17.5			2.65	
2248	105.1	Borrow C475 11472 L. Bag	0-2	ML	23	34	52	23	97					100								40	14	ML		9	(5)	96.5	22.0			2.55	
2249	105.2	Borrow C175 11475 L. Bag	4-7	CL	27	40	63	71	97					100								42	24	CL		8	(6)	92.0	23.0			[illegible]	

SCS-ENG-133
REV. 4-71

LABORATORY NO [illegible]

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	CONSOLIDATION TEST

PROJECT OR STATE [illegible] | SAMPLE LOCATION [illegible]

FIELD SAMPLE NO.	DEPTH	GEOLOGIC ORIGIN
[illegible]	[illegible]	Alluvium

TYPE OF SAMPLE	TESTED AT	APPROVED BY	DATE
[illegible]	[illegible]	Edgar F Strahl	9/18/72

CLASSIFICATION CL

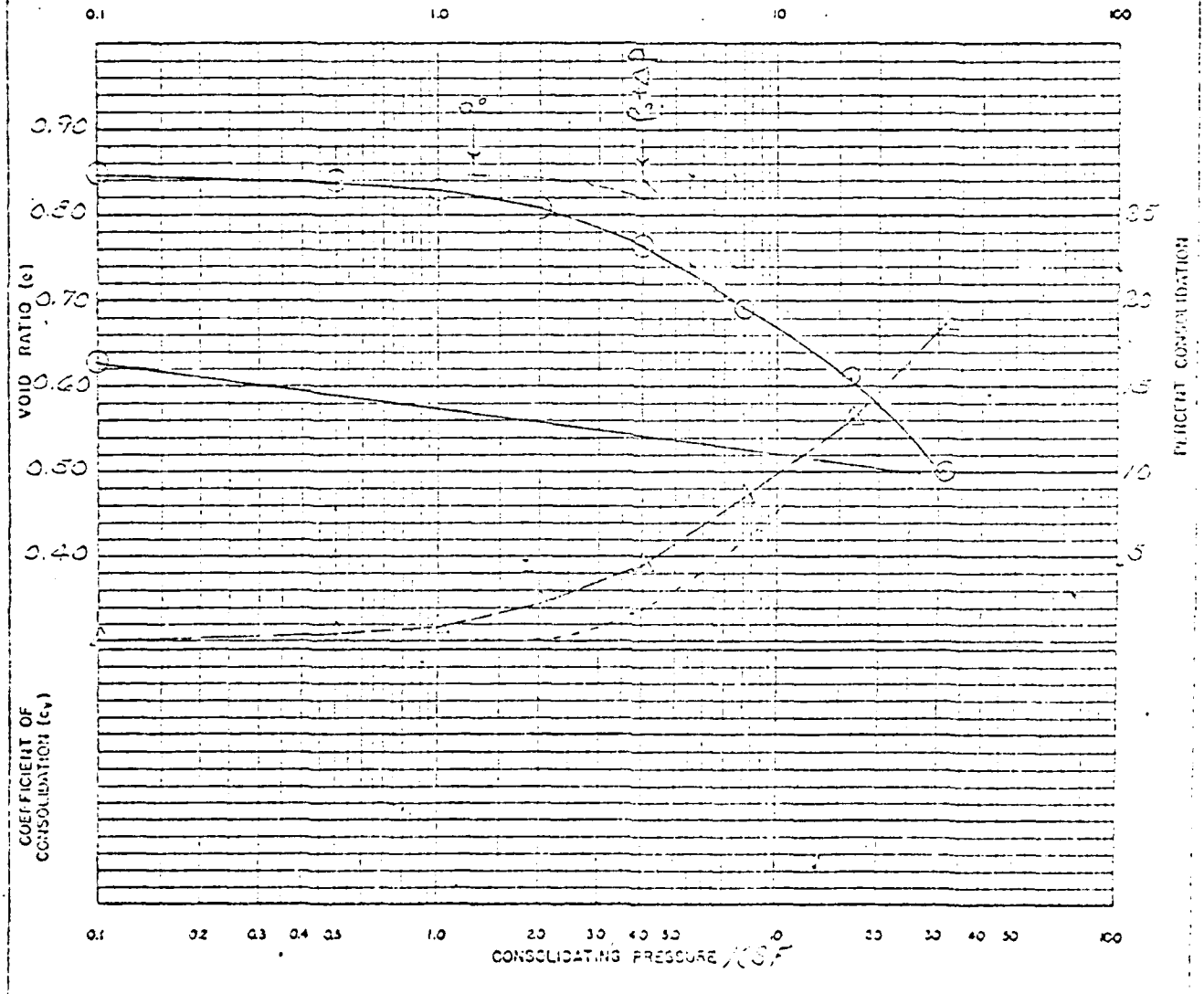
G_s 2.69 LL 46 PI 24

INITIAL DENSITY γ_d 102.8 pcf

INITIAL VOID RATIO, e_o 0.640

COMPRESSION INDEX, C_c _____

TEST SPECIFICATIONS:
Saturated at Start

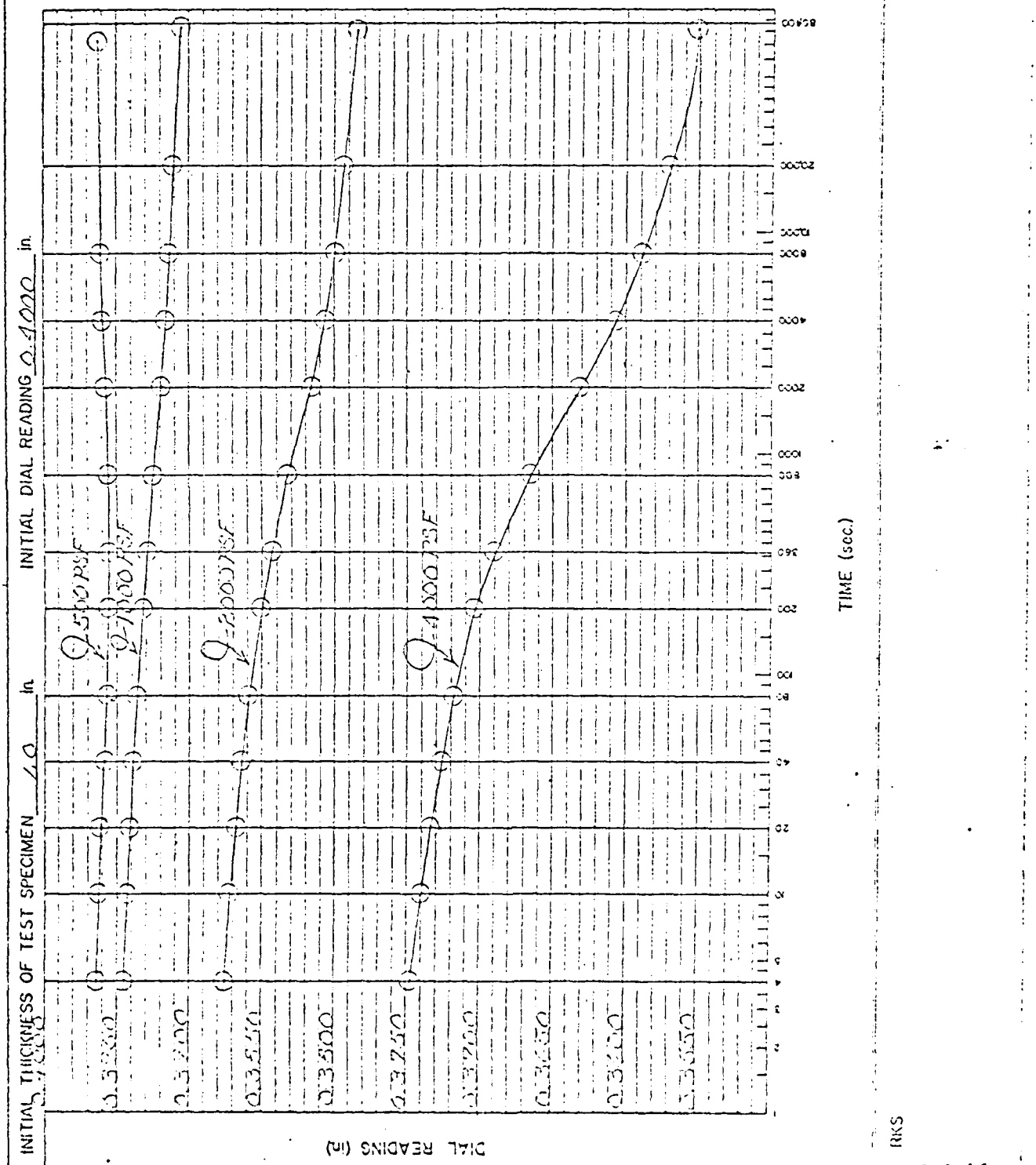


REMARKS

PLATE C-15

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	LOG TIME CONSOLIDATION

PROJECT and STATE			SAMPLE LOCATION
[illegible]			[illegible]
FIELD SAMPLE NO.	DEPTH	GEOLOGIC ORIGIN	
[illegible]	[illegible]		
TYPE OF SAMPLE	TESTED AT	APPROVED BY	DATE
[illegible]	[illegible]	[illegible]	9/18/[illegible]

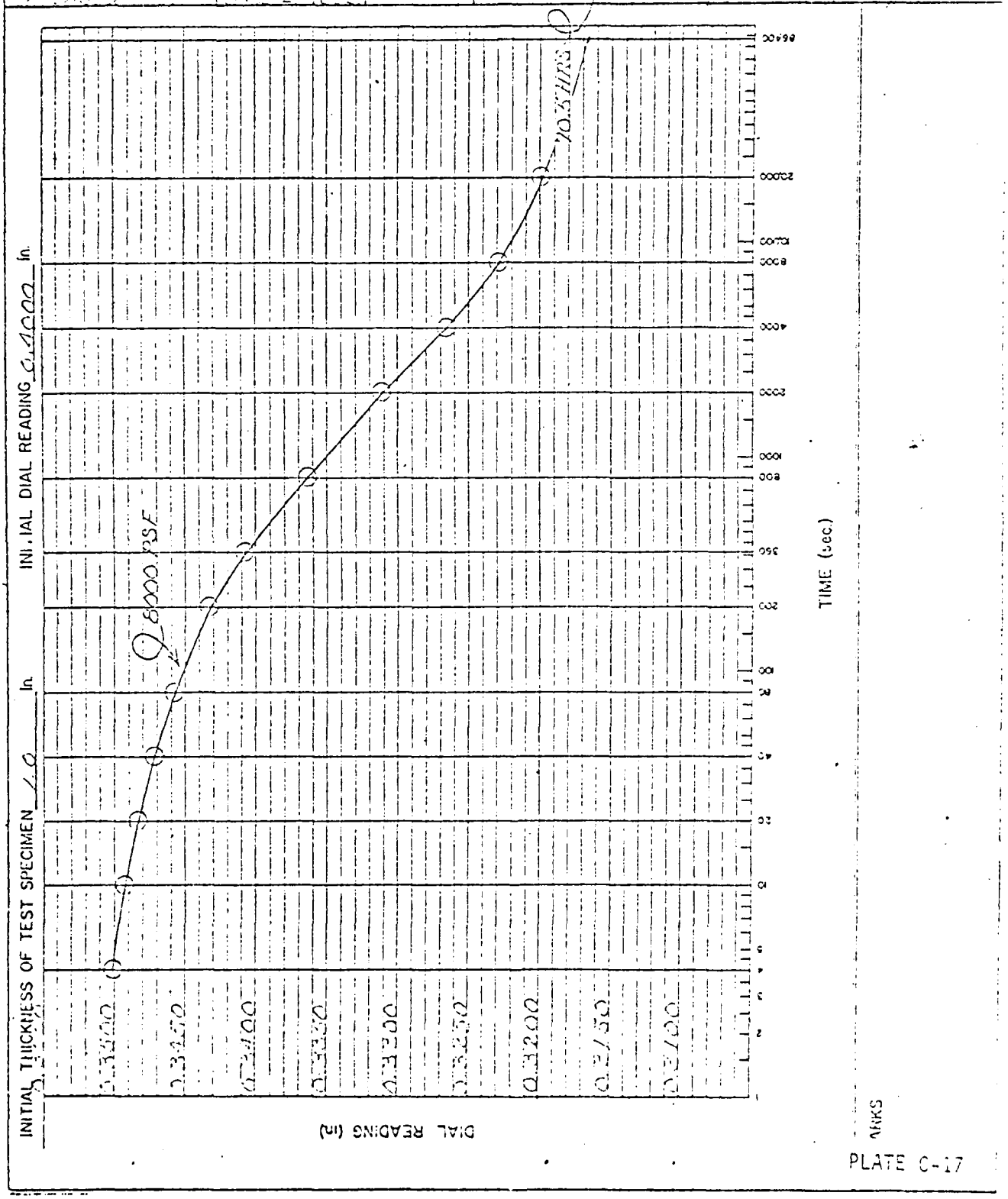


RKS

PLATE C-16

CONSOLIDATION

PROJECT and STATE			SAMPLE LOCATION
[illegible]			[illegible]
FIELD SAMPLE NO.	DEPTH	GEOLOGIC ORIGIN	
[illegible]	[illegible]		
TYPE OF SAMPLE	TESTED AT	APPROVED BY	DATE
[illegible]	[illegible]	[illegible]	8/8/7-



MKS

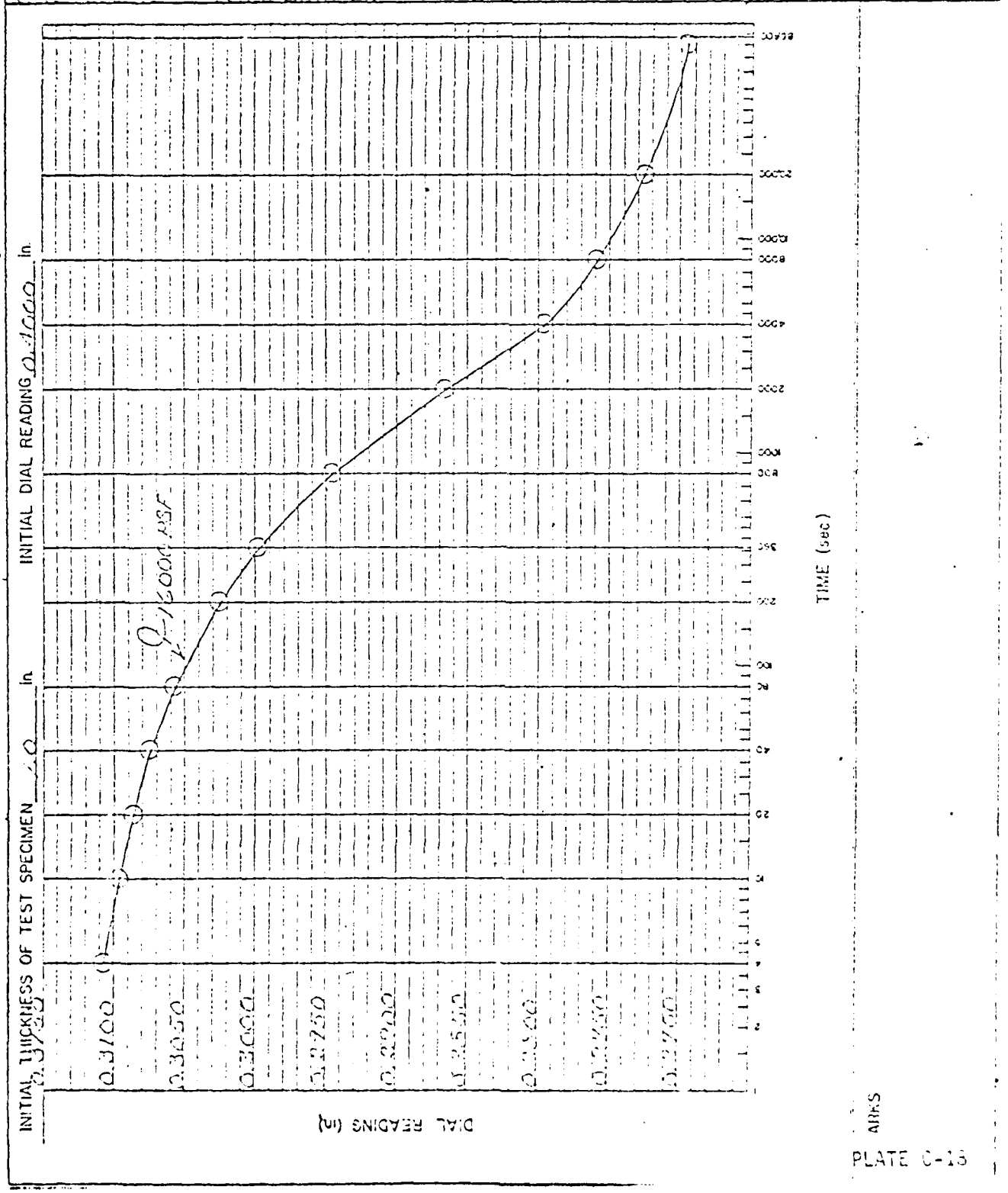
PLATE C-17

9-64

LABORATORY NO [illegible]

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	LOG TIME CONSOLIDATION

PROJECT and STATE			SAMPLE LOCATION
[illegible]			[illegible]
FIELD SAMPLE NO	DEPTH	GEOLOGIC ORIGIN	
[illegible]	[illegible]		
TYPE OF SAMPLE	TESTED AT	APPROVED BY	DATE
[illegible]	[illegible]	[illegible]	8/3/72



ARRS

PLATE C-16

Form SCS-128A
9-64

LABORATORY NO. [illegible]

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	LOG TIME CONSOLIDATION

PROJECT and STATE		SAMPLE LOCATION
[illegible]		[illegible]
FIELD SAMPLE NO.	DEPTH	GEOLOGIC ORIGIN
[illegible]	[illegible]	
TYPE OF SAMPLE	TESTED AT	APPROVED BY
[illegible]	[illegible]	[illegible]

DATE 8/3/[illegible]

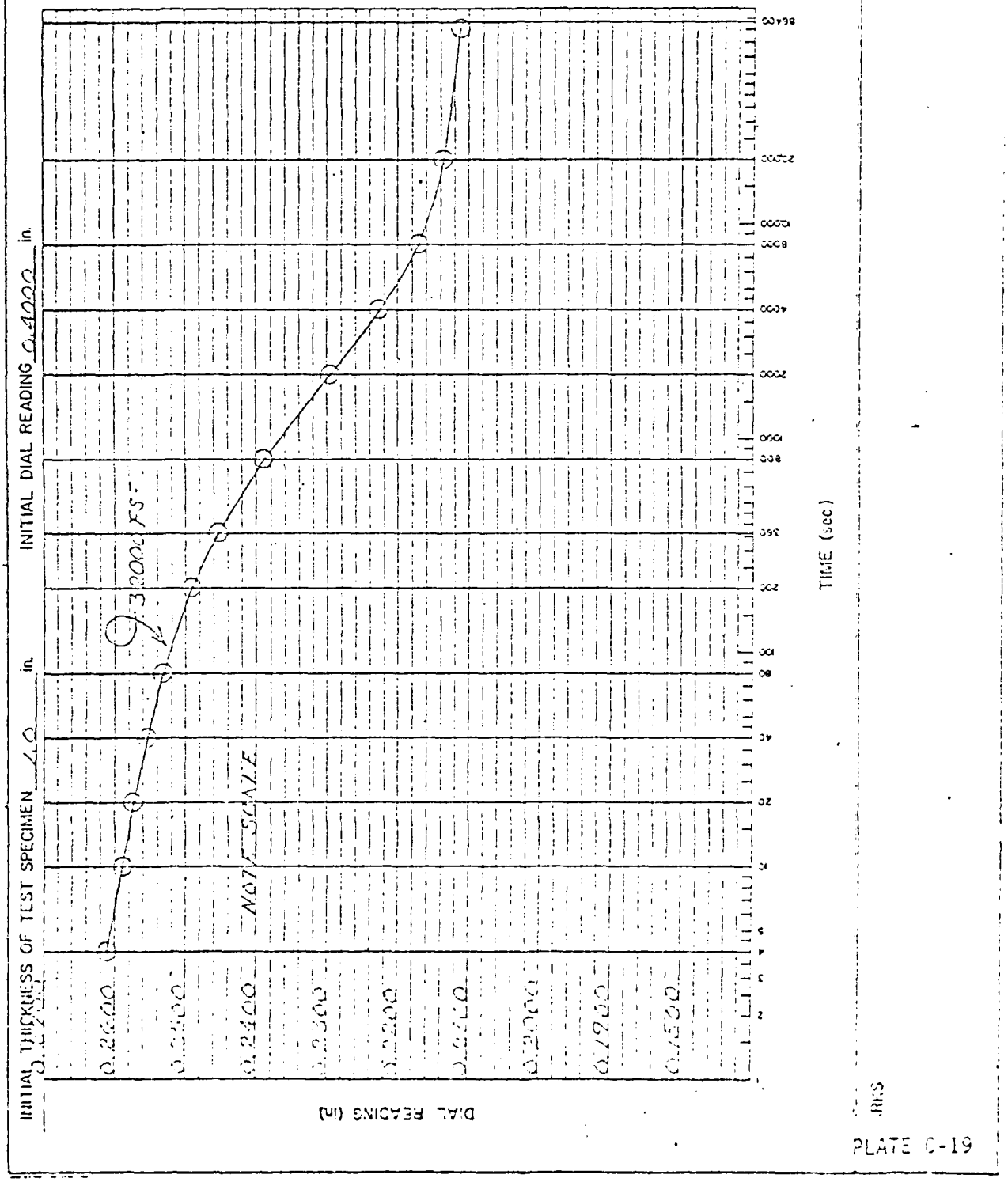


PLATE C-19

Form SCS-37
9-64

LABORATORY NO [illegible]

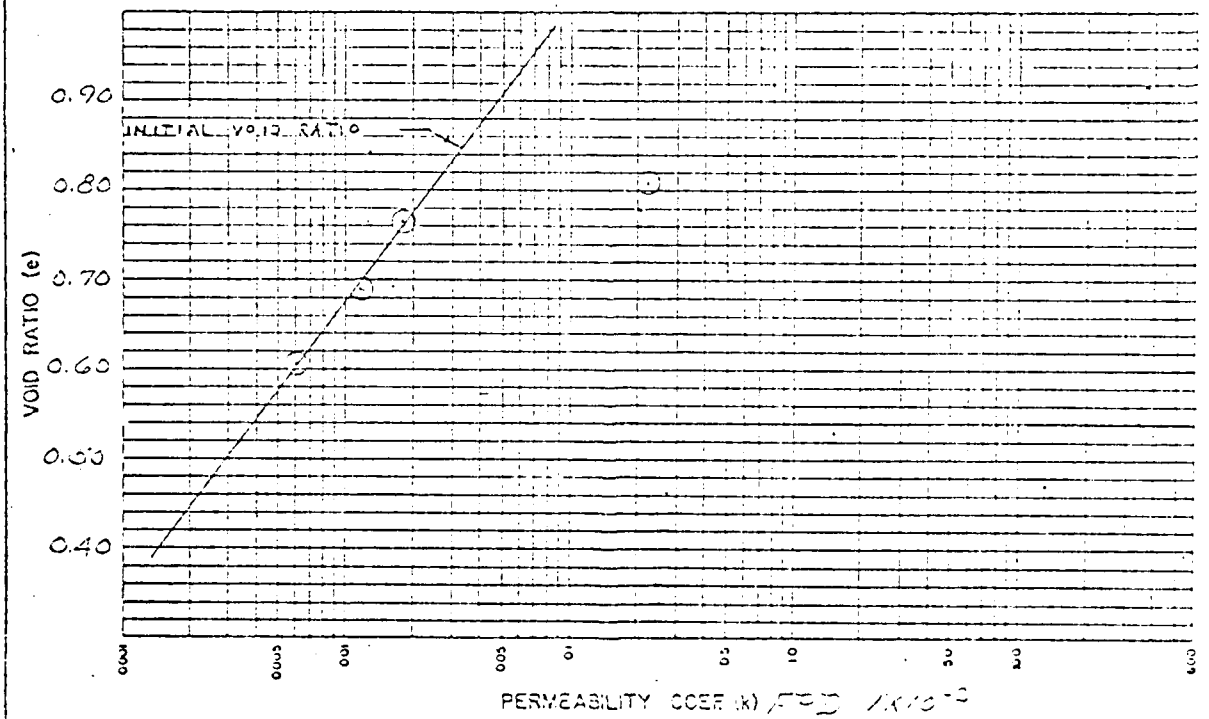
MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	SOIL PERMEABILITY

PROJECT and STATE: [illegible] | SAMPLE LOCATION: [illegible]

FIELD SAMPLE NO	DEPTH	GEOLOGIC ORIGIN	
[illegible]	[illegible]	Alluvium	
TYPE OF SAMPLE: UNDISTURBED	TESTED AT: [illegible]	APPROVED BY: Edgar F. Stoelo	DATE: 2/8/72

CLASSIFICATION GL — LL 45 PI 24 — SPECIFIC GRAVITY

TEST NO.	[illegible]	[illegible]	[illegible]	[illegible]	G_s (-) #4	2.69
INITIAL MOISTURE %					G_s (+) #4	
DRY DENSITY gm/cc / pcf	1.43	1.47	[illegible]	[illegible]	G_m (Bulk)(+) #4	
VOID RATIO	0.8042	0.7432	0.6521	[illegible]	TEST SPECIFICATIONS: Falling Head Perm Test on the Consolidation Sample	
PERMEABILITY COEF FPD	[illegible]	[illegible]	[illegible]	[illegible]		
PERCOLATION COEF						
H/L DURING TEST						



REMARKS

INITIAL K ≈ 0.00035 fpd

PLATE C-20

Form SCS 355-A
Rev 6-65

LABORATORY NO [illegible]

MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | TRIAXIAL SHEAR TEST

PROJECT and STATE		SAMPLE LOCATION
102 River Tributaries #2-5, Missouri		℄ dam 5+55

FIELD SAMPLE NO.	DEPTH	GEOLOGIC ORIGIN
302.3	10 - 12'	Alluvium

TYPE OF SAMPLE	TESTED AT	APPROVED BY	DATE
UNDISTURBED	SCS-Lincoln	Edgar F Steele	2/8/72

INDEX TEST DATA

USCS CL ; LL 45 ; PI 24

% FINER (mm): 0.002 27 ; 0.005 35 ;

0.074 (#200) 100

G_s (-#4) 2.59 ; G_s (+#4) ______

STANDARD: γ_d MAX. ______ pcf; w_o ______ %

MODIFIED: γ_d MAX. ______ pcf; w_o ______ %

SPECIMEN DATA

HEIGHT 3.0 "; DIAMETER 1.4 "

MATERIALS TESTED PASSED #4 SIEVE

METHOD OF PREPARATION TRIMMED FROM AN UNDISTURBED CORE

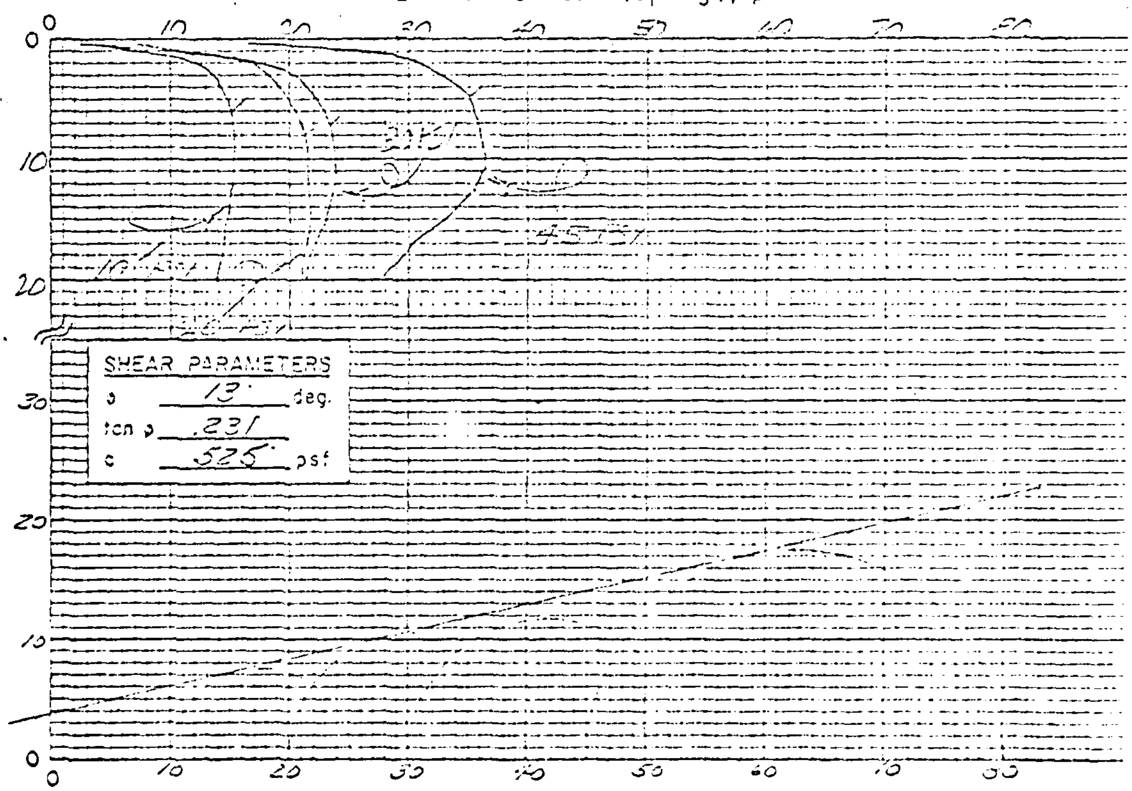
MOLDING MOISTURE ______ %

MOLDED AT ______ % OF γ_d MAXIMUM

TYPE OF TEST

UU ☐
CU ☒
$\overline{CU}$ ☐
CD ☐

DRY DENSITY: INITIAL (pcf ☐ g/cc ☒)	DRY DENSITY: CONSOLIDATED (pcf ☐ g/cc ☐)	B Parameter	MOISTURE CONTENT, %: START OF TEST	MOISTURE CONTENT, %: DEG. OF SAT. AT START OF TEST	MOISTURE CONTENT, %: END OF TEST	TIME OF CONSOLIDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ε (%)
1.39		0.93			52.7	16.42	10	15.1	6.0
1.40		0.96			30.6	17.08	20	21.2	8.0
1.42		0.97			29.2	17.58	30	23.5	7.0
1.47		1.00			25.8	18.00	45	35.1	4.3



REMARKS BACK-PRESSURED

[signature]

PLATE C-21

Form SCS 355 A
Rev 6-65

LABORATORY NO 221??

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	TRIAXIAL SHEAR TEST

PROJECT and STATE: Ko River Tributaries & C-5, Missouri
SAMPLE LOCATION: Borrow Area ?

FIELD SAMPLE NO.: 103.2 | DEPTH: 3-9' | GEOLOGIC ORIGIN:

TYPE OF SAMPLE: Composited | TESTED AT: Soil-Lincoln | APPROVED BY: Edgar F. Steele | DATE: 2/2/72

INDEX TEST DATA

USCS ML ; LL 41 ; PI 15
% FINER (mm): 0.002 20 ; 0.005 30 ;
0.074 (# 200) 96
G_s (-#4) 2.57 ; G_s (+#4) ____
STANDARD: γ_d MAX. 93.5 pcf; w_o 25.5 %
MODIFIED: γ_d MAX. ____ pcf; w_o ____ %

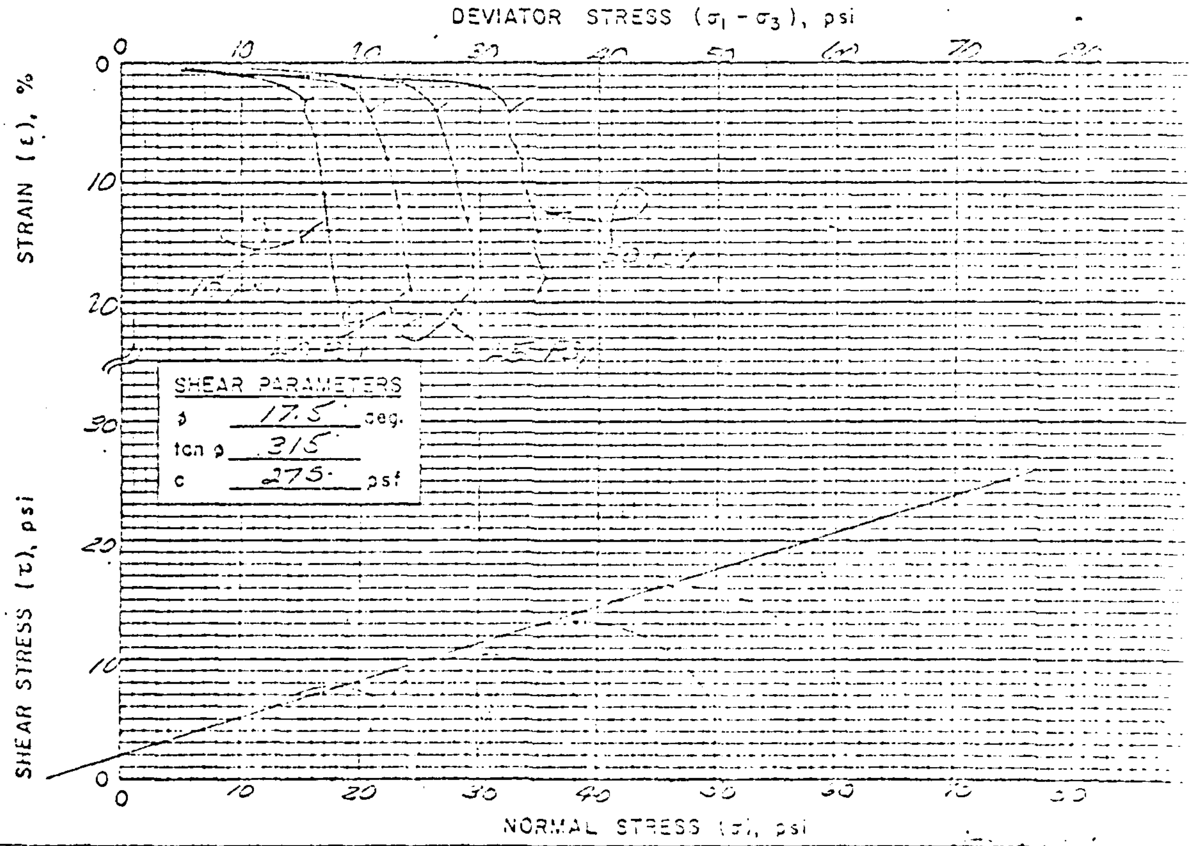
SPECIMEN DATA

HEIGHT 3.0 "; DIAMETER 1.4 "
MATERIALS TESTED PASSED #4 SIEVE
METHOD OF PREPARATION static molded in 3 lifts
MOLDING MOISTURE 26.1 %
MOLDED AT 94.5 % OF γ_d MAXIMUM

TYPE OF TEST

UU ☐
CU ☒
$\overline{CU}$ ☐
CD ☐

DRY DENSITY INITIAL pcf ☒ g/cc ☐	DRY DENSITY CONSOLIDATED pcf ☐ g/cc ☐	B. Parameter	MOISTURE CONTENT, % START OF TEST	DEG. OF SAT. AT START OF TEST	MOISTURE CONTENT, % END OF TEST	TIME OF CONSOLIDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ε (%)
88.4		0.96			31.1	17.00	10	15.4	20
88.4		0.99			30.4	16.17	20	20.3	20
88.5		0.95			28.4	64.17	30	32.4	20
88.1		0.96			29.5	16.75	25	26.3	20



SHEAR PARAMETERS
ϕ 17.5 deg.
tan ϕ .315
c 275 psf

REMARKS: Back-pressured

PLATE C-20

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE

PROJECT AND STATE: 132 River Tributaries, # C-5 Missouri.

FIELD SAMPLE NO.	LOCATION	DEPTH
101.2	Gamrow, D-20, 1+75	2-7'

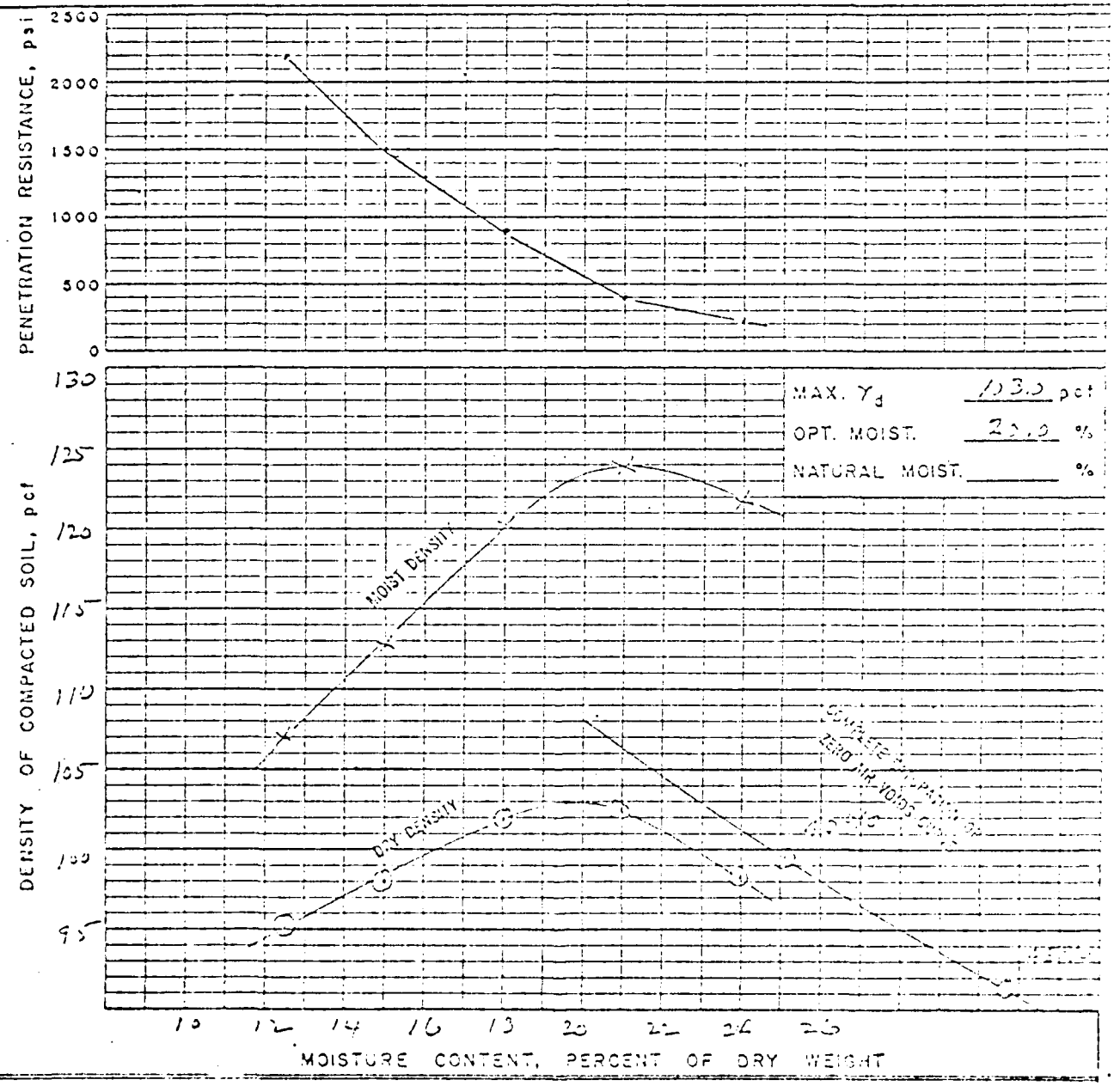
GEOLOGIC ORIGIN	TESTED AT	APPROVED BY	DATE
	Small-Lincoln	F.E.S	8/8/73

CLASSIFICATION CL LL 47 PI 25 | CURVE NO. 1 OF 6

MAX. PARTICLE SIZE INCLUDED IN TEST #4 " | STD. (ASTM D-698) ☒; METHOD A

SPECIFIC GRAVITY (G_s) { MINUS NO. 4 2.66 | MOD. (ASTM D-1557) ☐; METHOD

PLUS NO. 4 | OTHER TEST ☐ (SEE REMARKS)



REMARKS

PLATE C-33

Form SCS 355
Rev. 5-65

LABORATORY NO. 72W2291

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE

PROJECT AND STATE: 102 River Tributaries #C-5, Missouri.

FIELD SAMPLE NO.	LOCATION		DEPTH
103.1	Borrow, 2+00, 6+00.		0-2'
GEOLOGIC ORIGIN	TESTED AT	APPROVED BY	DATE
	SML-LINCOLN	[illegible]	2/2/72

CLASSIFICATION CL LL 49 PI 31

MAX. PARTICLE SIZE INCLUDED IN TEST < #4 "

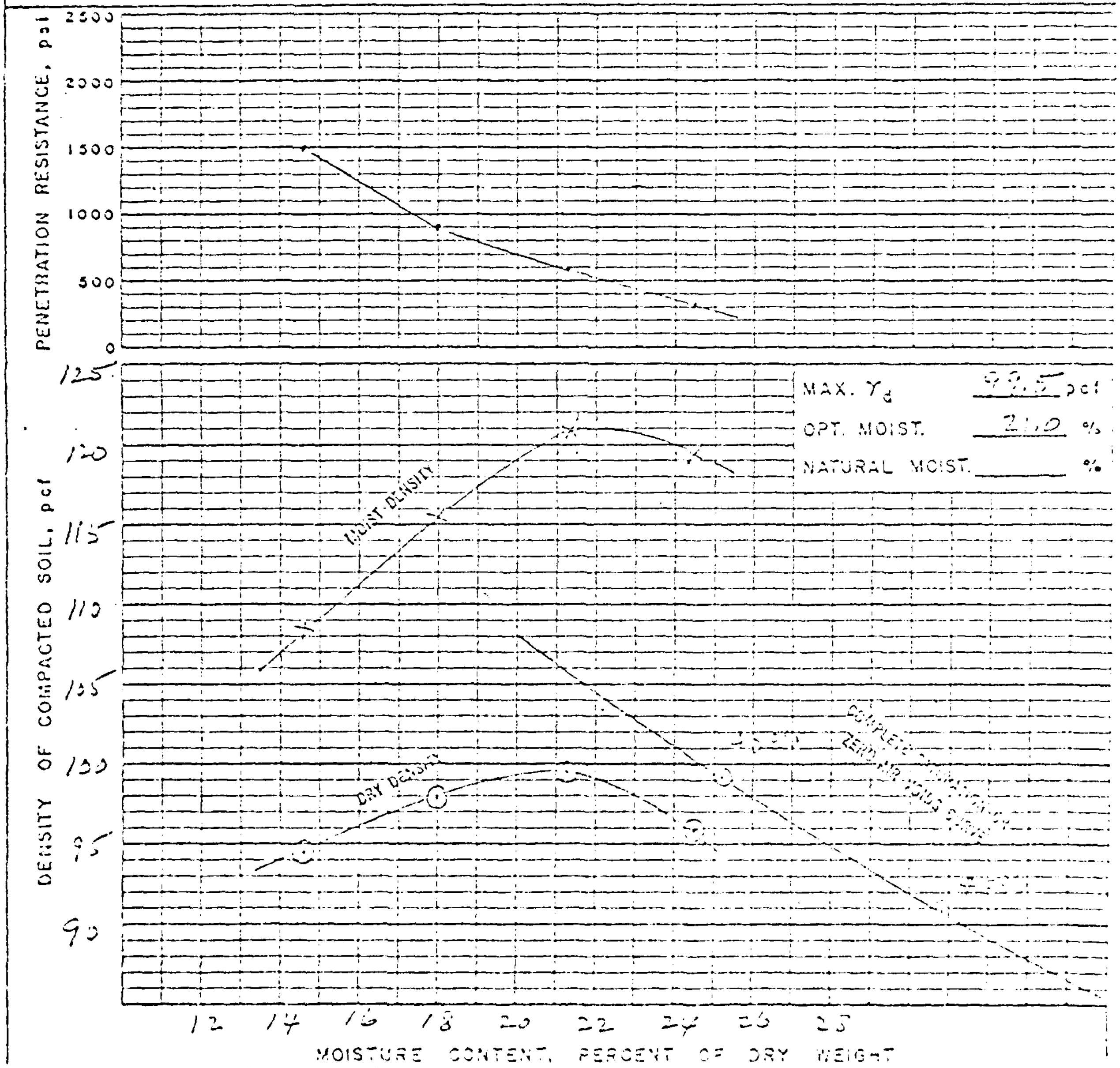
SPECIFIC GRAVITY (G_s) MINUS NO. 4 2.65 ; PLUS NO. 4 ____

CURVE NO. 2 OF 2

STD. (ASTM D-698) ☒; METHOD A

MOD. (ASTM D-1557) ☐; METHOD ____

OTHER TEST ☐ (SEE REMARKS)



REMARKS

PLATE C-24

Form SCS 352
Rev. 5-65

LABORATORY NO. 72W2[illegible]

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE

PROJECT AND STATE: 132 - River Tributaries #C-5, Missouri.

FIELD SAMPLE NO.	LOCATION			DEPTH
133.2	Borrow. 2+00. 6+00.			3-9'
GEOLOGIC ORIGIN		TESTED AT	APPROVED BY	DATE
		SML-LINCOLN	[illegible]	[illegible]

CLASSIFICATION ML LL 41 PI 15

CURVE NO. 3 OF 6

MAX. PARTICLE SIZE INCLUDED IN TEST #4 "

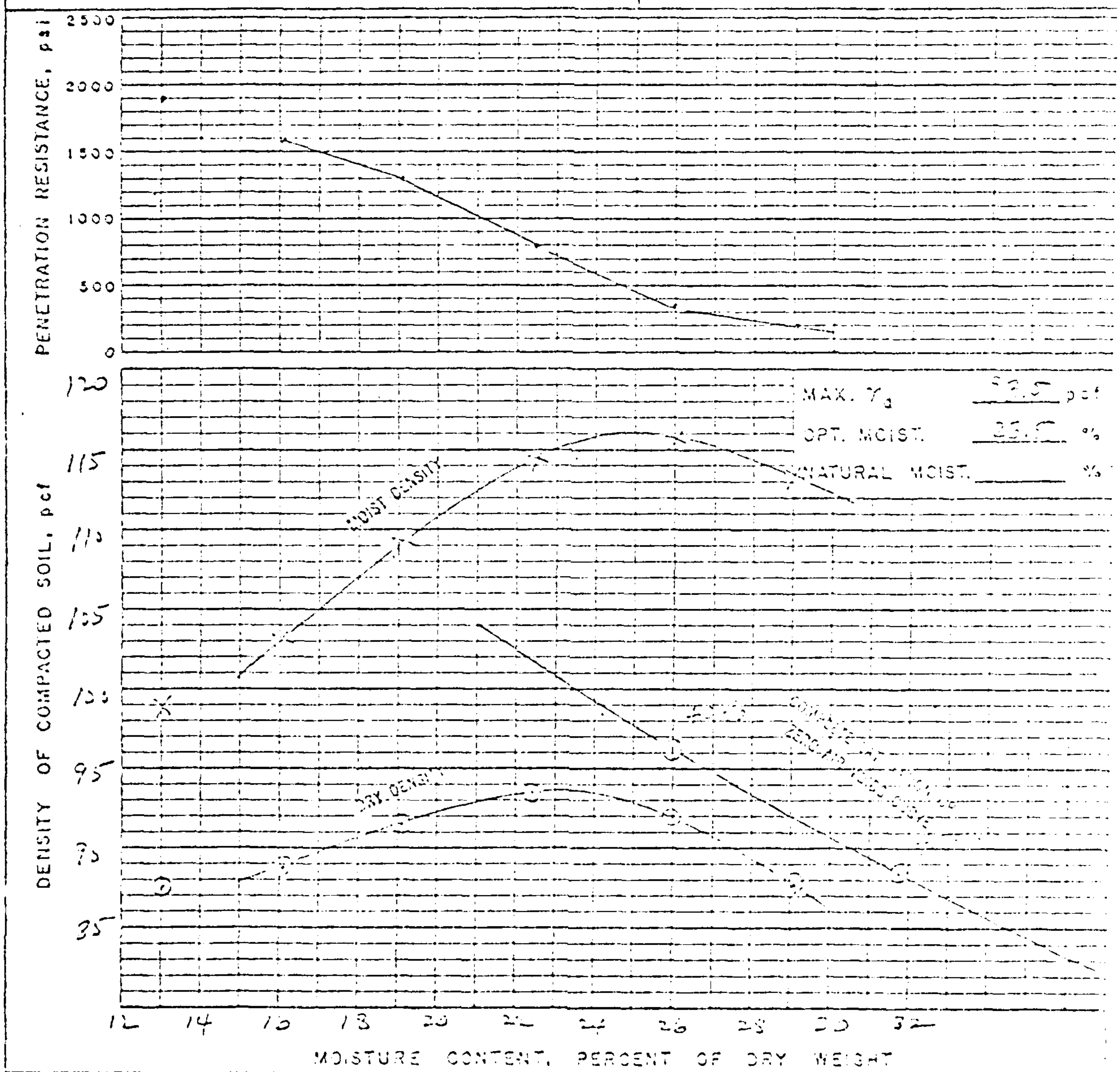
STD. (ASTM D-698) ☒; METHOD A

SPECIFIC GRAVITY (G_s) MINUS NO. 4 2.57

PLUS NO. 4

MOD. (ASTM D-1557) ☐; METHOD

OTHER TEST ☐ (SEE REMARKS)



REMARKS

PLATE I-35

Form SCS 352
Rev. 5-65

LABORATORY NO. 72W[illegible]

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE

PROJECT AND STATE: 132 River Tributaries [illegible] C-5, Missouri.

FIELD SAMPLE NO.	LOCATION	DEPTH
15-2	Borrow, [illegible] 9+[illegible].	2-5'

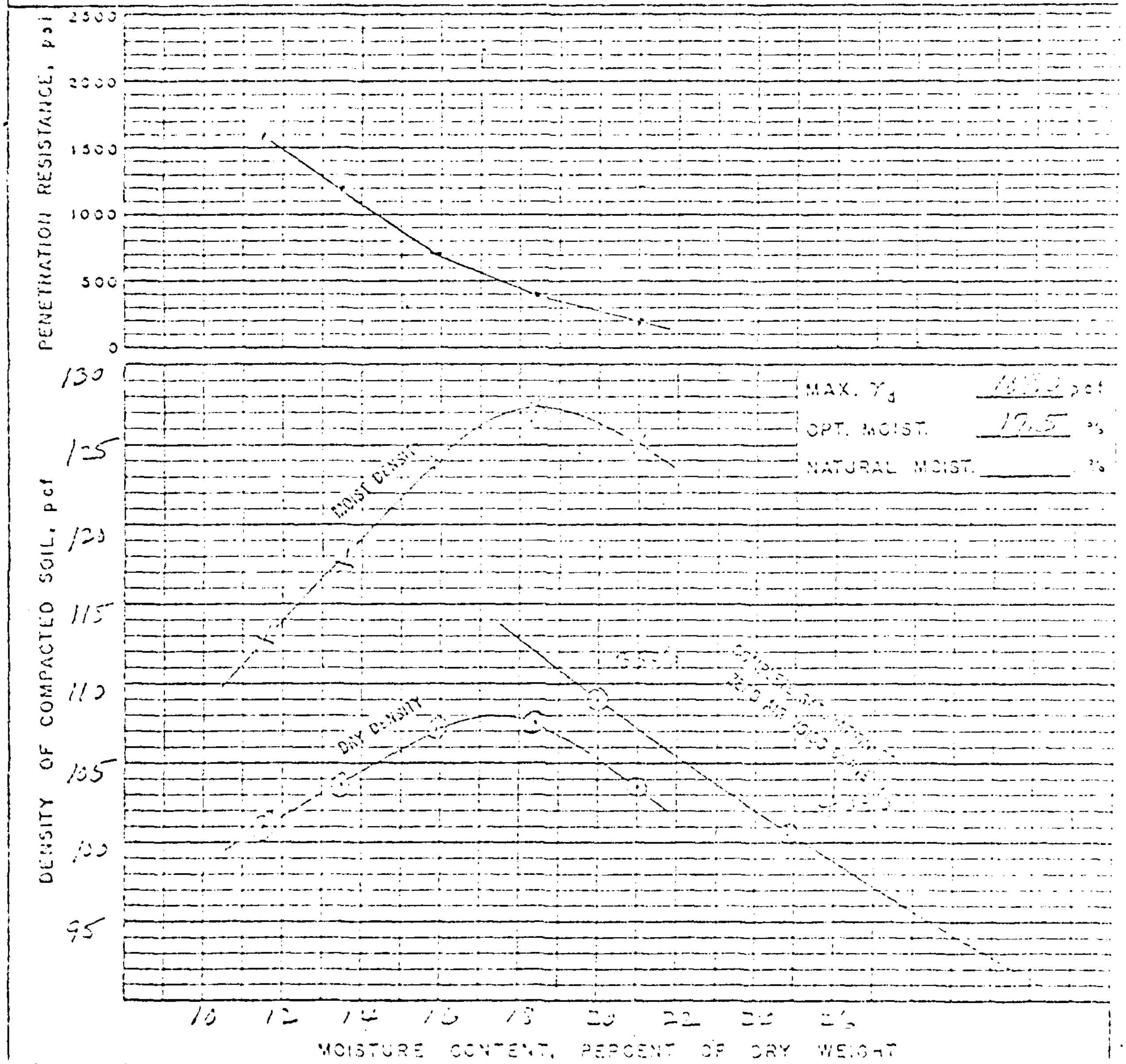
GEOLOGIC ORIGIN	TESTED AT	APPROVED BY	DATE
	SML-Lincoln	[illegible]	8/3/72

CLASSIFICATION CL LL 39 PI 23 — CURVE NO. 4 OF 6

MAX. PARTICLE SIZE INCLUDED IN TEST [illegible] " — STD. (ASTM D-698) ☒; METHOD A

SPECIFIC GRAVITY (G_s) MINUS NO. 4 2.68 — MOD. (ASTM D-1557) ☐; METHOD ____

PLUS NO. 4 ____ — OTHER TEST ☐ (SEE REMARKS)



REMARKS

PLATE C-25

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE

PROJECT OR STATE: 102 River Tributaries Fc-5 Missouri

FIELD SAMPLE NO	LOCATION	DEPTH
1351	13-57N-3W. C+75 11+75	0-3'

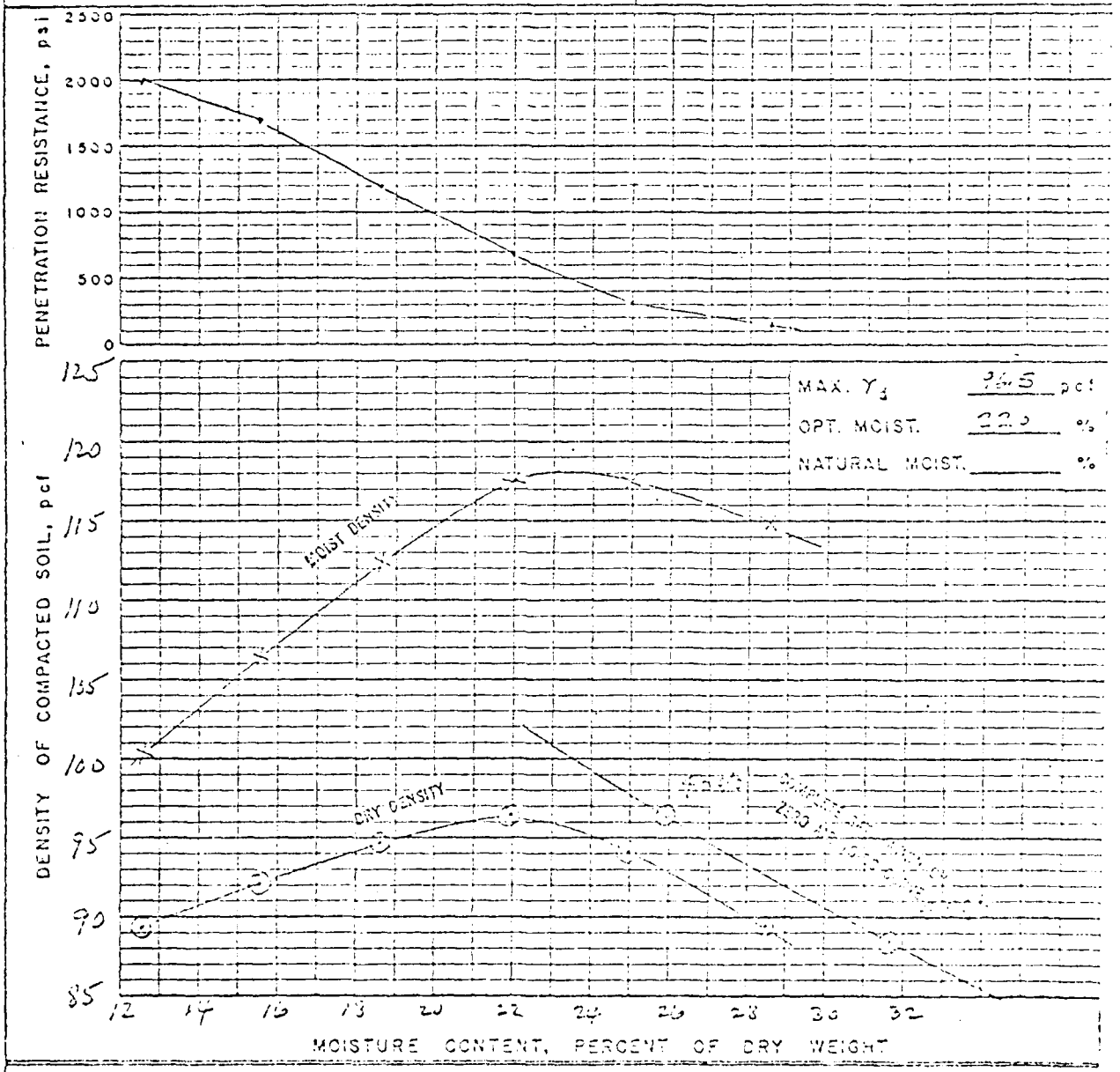
GEOLOGIC ORIGIN	TESTED AT	APPROVED BY	DATE
	SML-LINCOLN	RJR	8/2/72

CLASSIFICATION ML LL 40 PI 14 | CURVE NO. 5 OF 6

MAX. PARTICLE SIZE INCLUDED IN TEST 1/4" | STD. (ASTM D-698) ☒; METHOD A

SPECIFIC GRAVITY (G_s) { MINUS NO. 4 2.58 | MOD. (ASTM D-1557) ☐; METHOD

PLUS NO. 4 | OTHER TEST ☐ (SEE REMARKS)



REMARKS

PLATE C-27

Form SCS 352
Rev. 5-65

LABORATORY NO. [illegible]

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE

PROJECT AND STATE: 102 River Tributaries #C-5, Missouri

FIELD SAMPLE NO: 13512 | LOCATION: Borrow, C+75, 11+75 | DEPTH: 4-7'

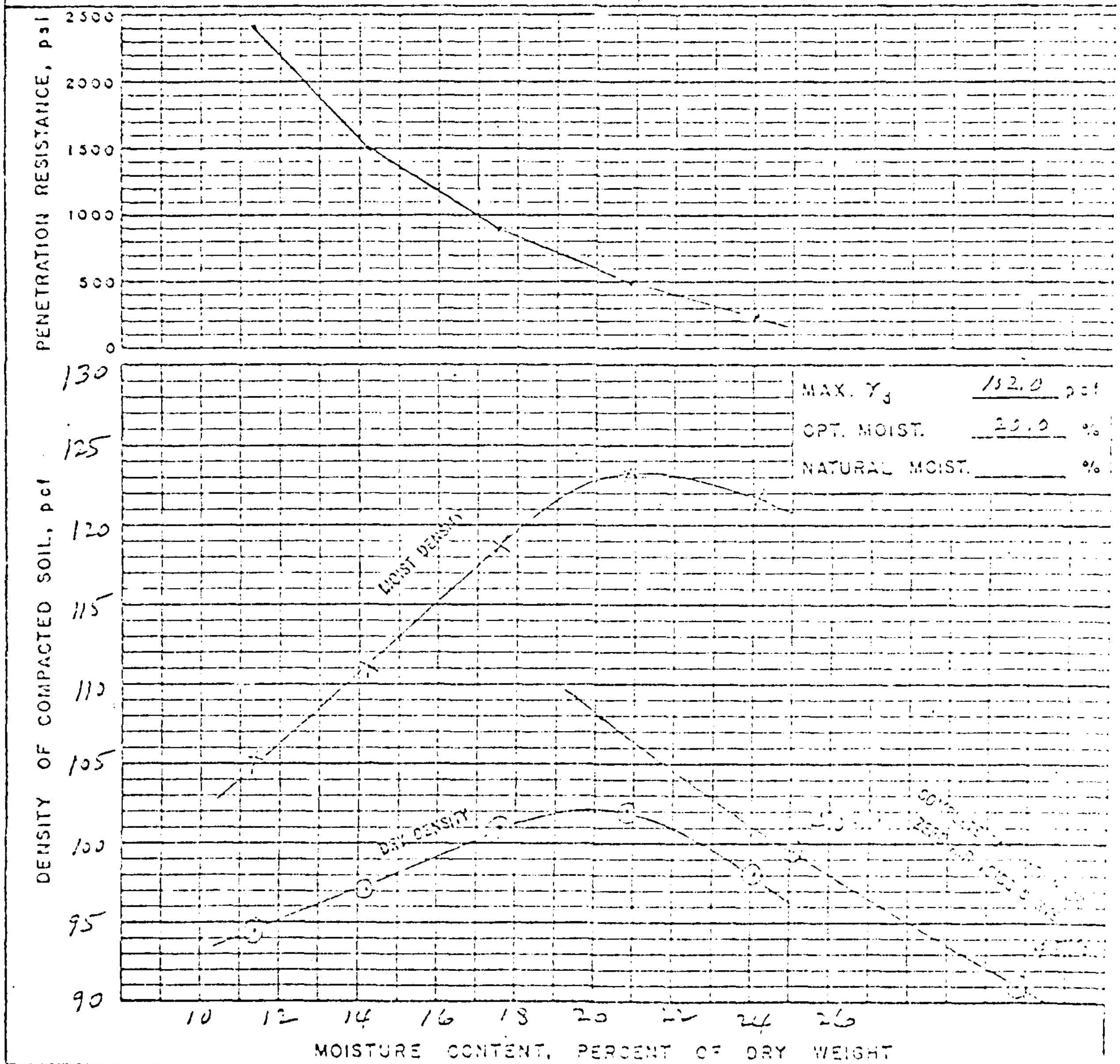
GEOLOGIC ORIGIN: | TESTED AT: SML-LINCOLN | APPROVED BY: [illegible] | DATE: 3/3/72

CLASSIFICATION: CL LL 47 PI 24 | CURVE NO. 6 OF 6

MAX. PARTICLE SIZE INCLUDED IN TEST: <#4 | STD. (ASTM D-698) ☒; METHOD A

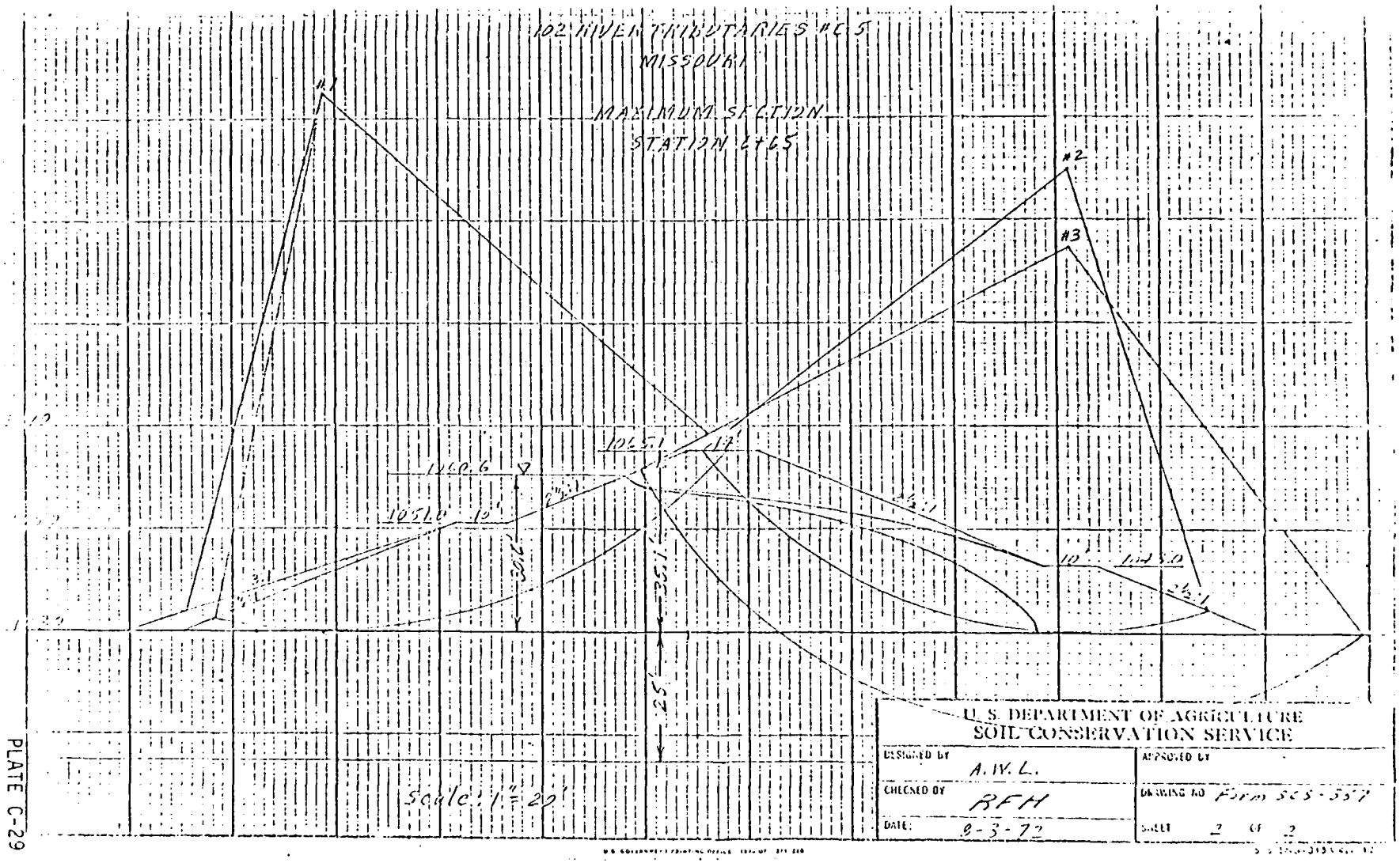
SPECIFIC GRAVITY (G_s) MINUS NO. 4: 2.65 | MOD. (ASTM D-1557) ☐; METHOD

PLUS NO. 4: | OTHER TEST ☐ (SEE REMARKS)



REMARKS

PLATE C-28



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DESIGNED BY A. W. L.	APPROVED BY
CHECKED BY RFH	DRAWING NO. Form SCS-537
DATE: 8-3-72	SHEET 2 OF 2

PLATE C-29

Form SCS 357
Rev. 6-63

MATERIALS TESTING REPORT | U.S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE

SUMMARY - SLOPE STABILITY ANALYSIS

PROJECT and STATE: 102 SILVER TAILINGS # C-5 MISSOURI
METHOD OF ANALYSIS: SWEDISH CIRCLE
ANALYZED AT: S.M.L., LINCOLN, NE
APPROVED BY:
DATE: 2-3-72

SOURCE AND USE OF MATERIALS	CLASSIFICATION	ADOPTED DESIGN DATA: Yd (pcf)	Ym (pcf)	Ysat (pcf)	Ysub (pcf)	φ (deg)	tan φ	c (psf)	REMARKS
① Foundation	CL	88.8		117.0	54.5	13	.231	525	
② Embankment	ML	89.4	109.0	116.5	54.0	17.5	.315	275	
③									
④									
⑤									
⑥									
⑦									
⑧									

TRIAL NO.	SLOPE	CONDITIONS	F_s Bishop	F_s Swedish
		Upstream - Fulldrawdown Dnstr. - Steady Seepage Max Sect. @ Station 4+65		
1 Up	2½:1	Emb. (17.5°-275) ϕ 25' Found (13°-525) - 10' berm @ elev. 1051.0.	1.29	1.30
1A Up	2½:1	Emb. (17.5°-275) ϕ 25' Found (13°-525) - 10' berm @ elev. 1051.0.	1.41	1.41
2 Dn	2½:1	Emb. (17.5°-275) ϕ 25' Found (13°-525) - 10' berm @ elev. 1043.0	1.42	1.39
3 Dn	2½:1	Emb. (17.5°-275) ϕ 25' Found (13°-525) - 10' berm @ elev. 1043.0 ϕ Drain @ c/b = e.l.	1.54	1.44

Stability Analysis by computer (CICES)
(only weakest arcs shown on sketch)

PLATE C-30

Sheet 1 of 2

RTSC-FW-ENG-42
6-70
(File Code ENG-22)

State: Mississ	Project: 102 River Trib	Site: C-5	Determination of s and Probable Joint Gaps

Sta. 5+55 H = 24' ft. d = 30' ft. B = 160' ft.

s = 0.6 ft. ∅ = 13 deg. c = 525 psf

P = _____ psf p = H γ_m = 2800 psf γ_m = 116.5

Determination of s

$\bar{p} = \frac{H}{2}\gamma_m + y \cdot \gamma_b = (\frac{24}{2})(116.5) = 1400$
$+ (\quad)(\quad) = $ _____

$\bar{p}$ = 1400 psf

Then, $\sigma_3 = 2/3\ \bar{p}$ = 933 psf

$$\sigma_1 = \frac{2c}{\tan(45° - \phi/2)} + \frac{\sigma_3}{\tan^2(45° - \phi/2)}$$

$$= \frac{2(525)}{\tan(.7954)} + \frac{933}{\tan^2(.6327)} = 1320 + 1470 = 2790 \text{ psf}$$

$$s = \frac{\sigma_1 - \sigma_3}{2} = \frac{(2790) - (933)}{2} = \frac{1857}{2} = 928 \text{ psf}$$

Joint Gap

B/d = (160)/(30) = 5.34 R_1 = 0.32
B/H = (160)/(24) = 6.67

$$R_2 = \frac{2\sigma d}{sB} + 0.1 = \frac{2(2800)(30)}{(928)(160)} + 0.1$$

= 1.13 + 0.1 = 1.23

$\epsilon_{hm} = R_1 \cdot R_2 \cdot \delta/d$ = (0.32)(1.23)(0.02) = 0.00785 ft./ft.

$g_s = \epsilon_{hm} \cdot 12 \cdot L$ = (\quad)(12)(\quad) = _____ in.

$g_r = \frac{2.5\ D_o\ \delta}{B} = 2.5\ \frac{(\quad)(\quad)}{(\quad)} \leq$ _____ in.

J = g_s + g_r + F.S. = _____ + _____ + F.S.

= _____ + F.S.

PLATE C-31

Form SCS-376A
Sheet 1 of 3

10-59

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

te Missouri County Nodaway ; ¼, NW ¼, Sec. 29, T 65N R 35W ; Watershed 102 River Tributari

Subwatershed ____ Fund class 08-3 (FP-2, WP-1, etc.) Site number C-5 Site group I Structure class b

Investigated by [signature] (signature and title) Equipment used Failing 1500 (Type, size, make, model, etc.) Date 3/28/72

SITE DATA

Drainage area size 2.02 sq. mi., 1293 acres. Type of structure DI Purpose FWR

Direction of valley trend (downstream) E Maximum height of fill 35.1 feet. Length of fill 825 feet

Estimated volume of compacted fill required 38,000 yards

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
Sediment	150	22.8	21.0
Floodwater	360	35.0	30.6

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Disected Till Plain, Topography Rolling, Attitude of beds: Dip - Strike -

Steepness of abutments: Left 8 percent; Right 13 percent. Width of floodplain at centerline of dam 0 feet

General geology of site: The site is located in National Soil Resource Area 109, The Iowa and Missouri Heavy Till Plain. The Kansan Till is a stiff silty clay with approximately 30 to 35 percent clay and 25 to 30 percent coarse material which is chiefly sand and gravel size. Cobbles may be encountered but boulder size rocks are rarely found. The depth to bedrock was not determined.

PLATE C-32

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

102 River Tributaries
C-5

FORM SCS-3768
REV. 2-64
SHEET 2 OF 3

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE centerline dam, principal spillway, emergency spillway, stream channel, borrow area
(CENTERLINE OF DAM, PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, THE STREAM CHANNEL, INVESTIGATIONS FOR DRAINAGE OF STRUCTURE, BORROW AREA, RESERVOIR BASIN, ETC.)

DRILLING PROGRAM

EQUIPMENT USED	NUMBER OF HOLES		NUMBER OF SAMPLES TAKEN		
			UNDISTURBED	DISTURBED	
	EXPLORATION	SAMPLING	(STATE TYPE)	LARGE	SMALL
5 1/2" slat auger	8	6	shelby	10 bag	
Std. split tube		1			5 jar
Hand auger	3				
TOTAL	11	7	1	10	5

SUMMARY OF FINDINGS
(INCLUDE ONLY FACTUAL DATA)

The upper abutments and the emergency spillway area is stiff silty clay till which also underlies the alluvial material of the lower slopes of the abutments and across the valley floor. The alluvial soil and underlying material is silty clay classified as firm to stiff. Sandy material classified as SC was encountered in test hole 6 and occurs from 23 to 36 feet. This is interpreted as a sand pocket in the clay till. The stiff alluvium forms the foundation of the principal spillway. The borrow material will be available below the crest elevation of the principal spillway and sufficient quantities will be available within easy haul distance of the dam.

PLATE C-33

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-376C
REV. 2-64
SHEET 3 OF 3

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

WATERSHED	SUBWATERSHED	COUNTY	STATE
102 River Tribs.		Nodaway	Missouri

SITE NO.	SITE GROUP	STRUCTURE CLASS	INVESTIGATED BY: (SIGNATURE OF GEOLOGIST)	DATE
C-5	I	b	[signature]	3/28/72

INTERPRETATIONS AND CONCLUSIONS

Foundation
Foundation materials are generally similar across the valley floor and strength appeared adequate for the proposed dam.

Principal Spillway
Foundation materials are uniform along the centerline. Strength appeared adequate; however, since a concrete pipe is to be used an undisturbed sample was taken.

Emergency Spillway
The emergency spillway cuts will be into till. Samples were not taken. Placement of the material should be similar to sample 104.2.

Channel
The channel in the foundation is constructed. Channel deposits are silts with some accumulation of iron concretion in the size up to fine gravel. Deposits are subject to seasonal changes.

Borrow
There is adequate borrow available mostly from the alluvial soil classified ML in the surface and CL below. Some till will be available in the area of test hole 104.

PLATE C-34

Engineer's Report
Foundation Investigation
Structure C-5
102 River Tributaries Watershed

April 17, 1972

Recommended Core Trench Depth

The following are the recommended depths for the core trench:

Sta.	Elev.
3+00	1054.5
3+50	1047.0
4+00	1043.0
5+00	1037.0
6+00	1035.0
6+50	1027.0
6+75	1027.0
7+15	1039.6
8+00	1043.0
8+50	1047.0
9+00	1055.0

The above recommended core depths should provide a near positive cutoff and foundation drainage should not be necessary.

Stream Channel Cleanout

The recent channel fill varies from one-half ($\frac{1}{2}$) foot to one and one-half ($1\frac{1}{2}$) foot. Stream channel cleanout beyond the work necessary to strip the area should not be needed. Additional bank sloping will not be required along the stream channel.

Use of Material From Required Excavations

The materials from the required structure and core trench excavations will need to be either stock-piled for future use or wasted during the excavation operation. The material from the emergency spillway should be classified as borrow and used in the earth fill for the dam and back fill of the other excavation areas.

Borrow

Adequate borrow will be available below the principal[a/] spillway elevation within the pool area. There is a good supply of ML material which should be placed on the outer shell of the dam. This will facilitate vegetation establishment and reduce possible shrink-swell problems of the CL material. It will not be necessary to designate a zone fill. The above suggested placement can be controlled by the engineer.

Special Conditions

The only special condition that I am aware of at the present time is a tile drain outlet which crosses through the foundation of the dam and outletting approximately 70' downstream from the centerline. I would recommend that this drain be completely removed throughout the foundation area and the trench be back filled with compacted earth fill.

Principal Spillway

The principal spillway is designed to be located at centerline of the dam, STA 5+55 and will be constructed from 36" diameter reinforced concrete pipe.

Harold B. Townsend, Jr.
Project Engineer

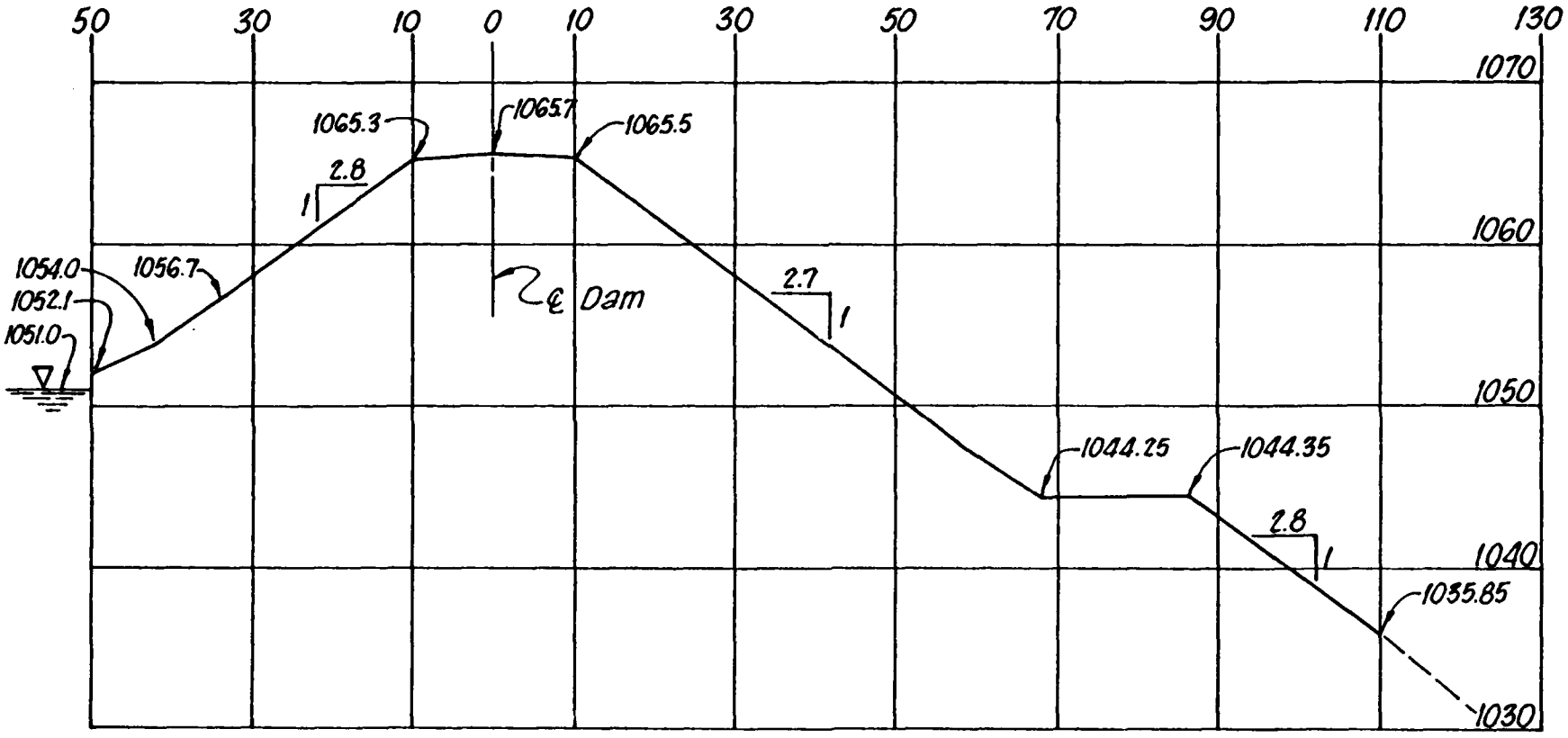


PLATE C-37

SECTION AT *STA. 7+00

Scale: 1" = 20' H.
1" = 10' V.

* Inspection Teams Stationing

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs (see this Section).

   a. Twenty-four hour, 100-year rainfall for the dam location was taken from the data for the rainfall station at Maryville, MO., as supplied by the St. Louis District, Corps of Engineers per their letter dated 6 March 1979. The twenty-four hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology.

   b. Drainage area = 2.18 square miles (1398 acres).

   c. Time of concentration of runoff = 47 minutes (computed from "Kirpich" formula).

   d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the 100-year precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the orifice opening of the riser.

   e. The total twenty-four hour storm duration losses for the 100-year storm were 2.64 inches. The total losses for the PMF storm were 1.44 inches. These data are based on SCS runoff curve No. 89 and No. 77 for antecedent moisture conditions SCS AMC III and AMC II respectively. The watershed is composed of primarily SCS soil group B (Sharpsburg-Adair-Shelby-Colo soils) and consists mostly of alfalfa and grass with some cropland planted on the contour.

   f. Average soil loss rate = 0.06 inch per hour approximately (for PMF storm, AMC III).

2. The discharge ratings for the principal spillway were developed using equations for orifice, weir, and full conduit flow. They are as follows:

a. Orifice flow equation ($Q = CA\sqrt{2gH}$)
where C = orifice coefficient = 0.6
A = area of opening, ft^2 = 4.0
H = total head, ft.

b. Weir flow equation ($Qw = CLH^{1.5}$)
where C = weir coefficient = 3.1
L = length of weir, ft. = 16.33
H = total head, ft.

c. Full conduit flow equation

$$Q = a\sqrt{\frac{2gH}{1 + K_e + K_b + K_pL}}$$

where a = cross-sectional area of pipe, ft^2 = 7.07
H = total head, ft.
K_e = coefficient for entrance loss = 0.5
K_b = coefficient for bend loss = 0.45
K_p = coefficient for pipe friction loss = 0.00963
L = length of pipe, ft. = 176

The emergency spillway discharge rating was developed using the Corps of Engineers Surface Water Profile HEC-2 computer program.

The flows over the dam crest were developed using the HEC-1 (Dam Safety Version) program with a discharge coefficient of 3.0 and a value of 1.5 for the exponent of head.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The output and plotted hydrographs are shown in this Section.

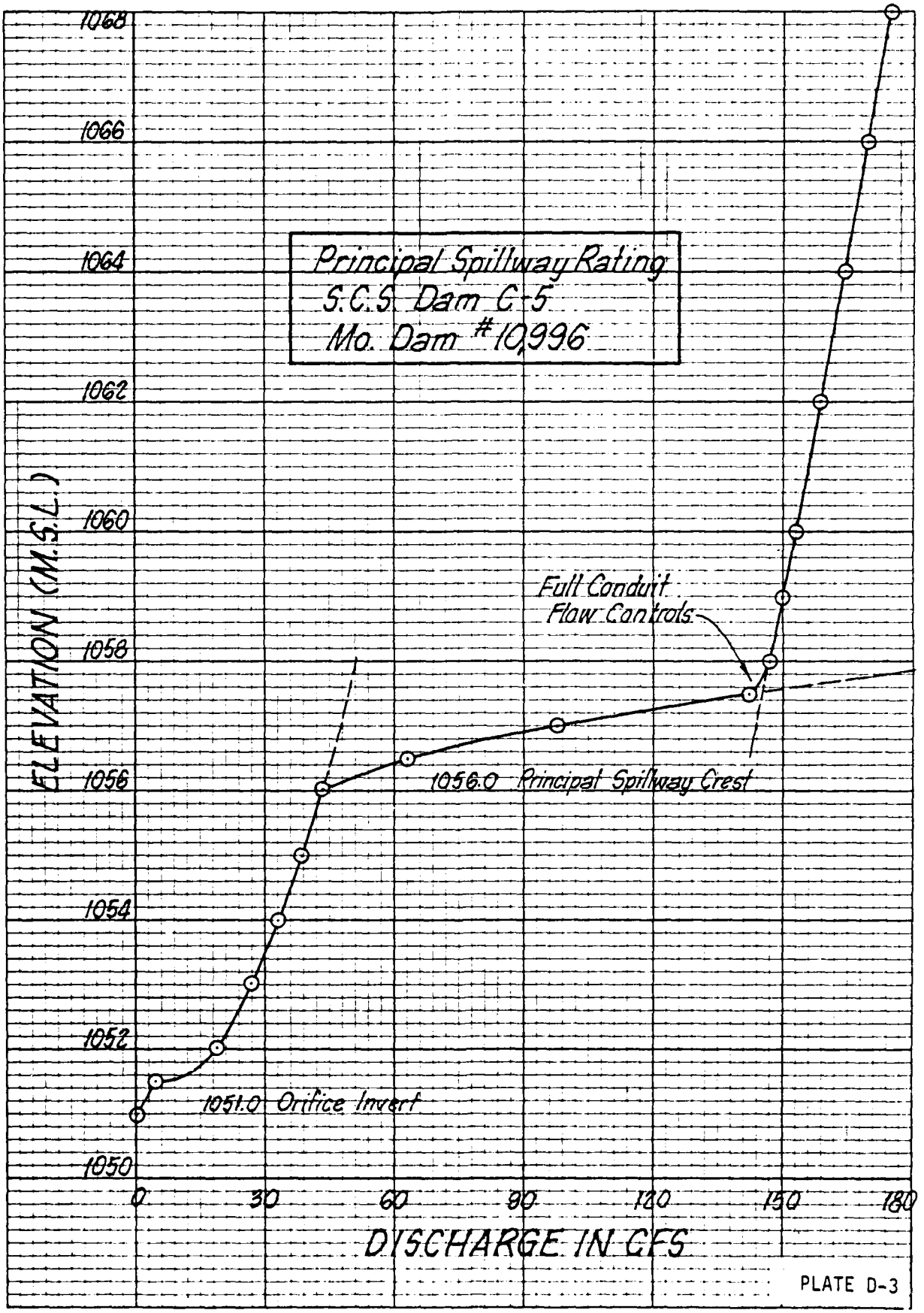

Principal Spillway Rating
S.C.S. Dam C-5
Mo. Dam #10,996
ELEVATION (M.S.L.)
1068
1066
1064
1062
1060
1058
1056
1054
1052
1050
Full Conduit
Flow Controls
1056.0 Principal Spillway Crest
1051.0 Orifice Invert
0
30
60
90
120
150
180
DISCHARGE IN CFS

PLATE D-3

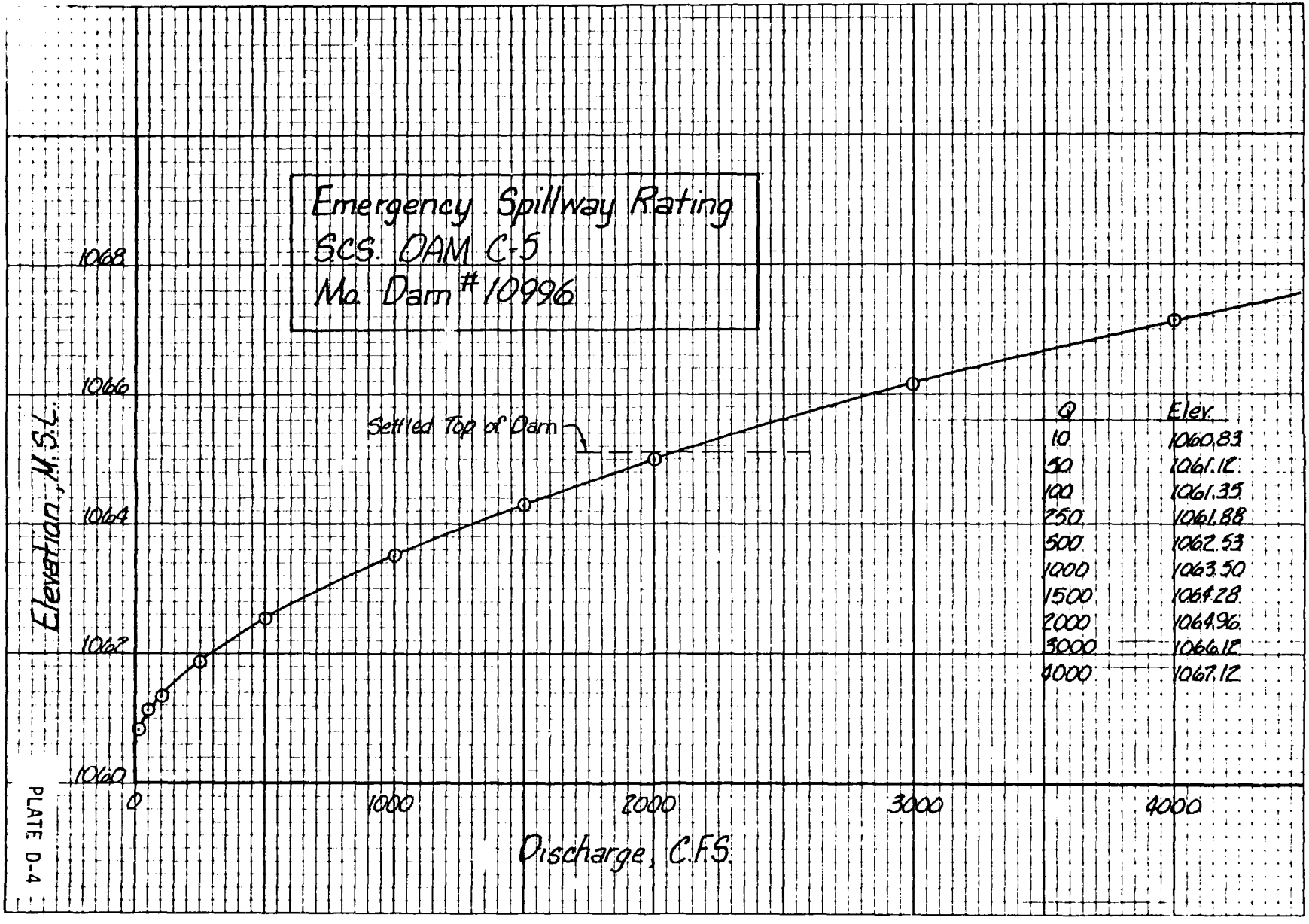


PLATE D-4

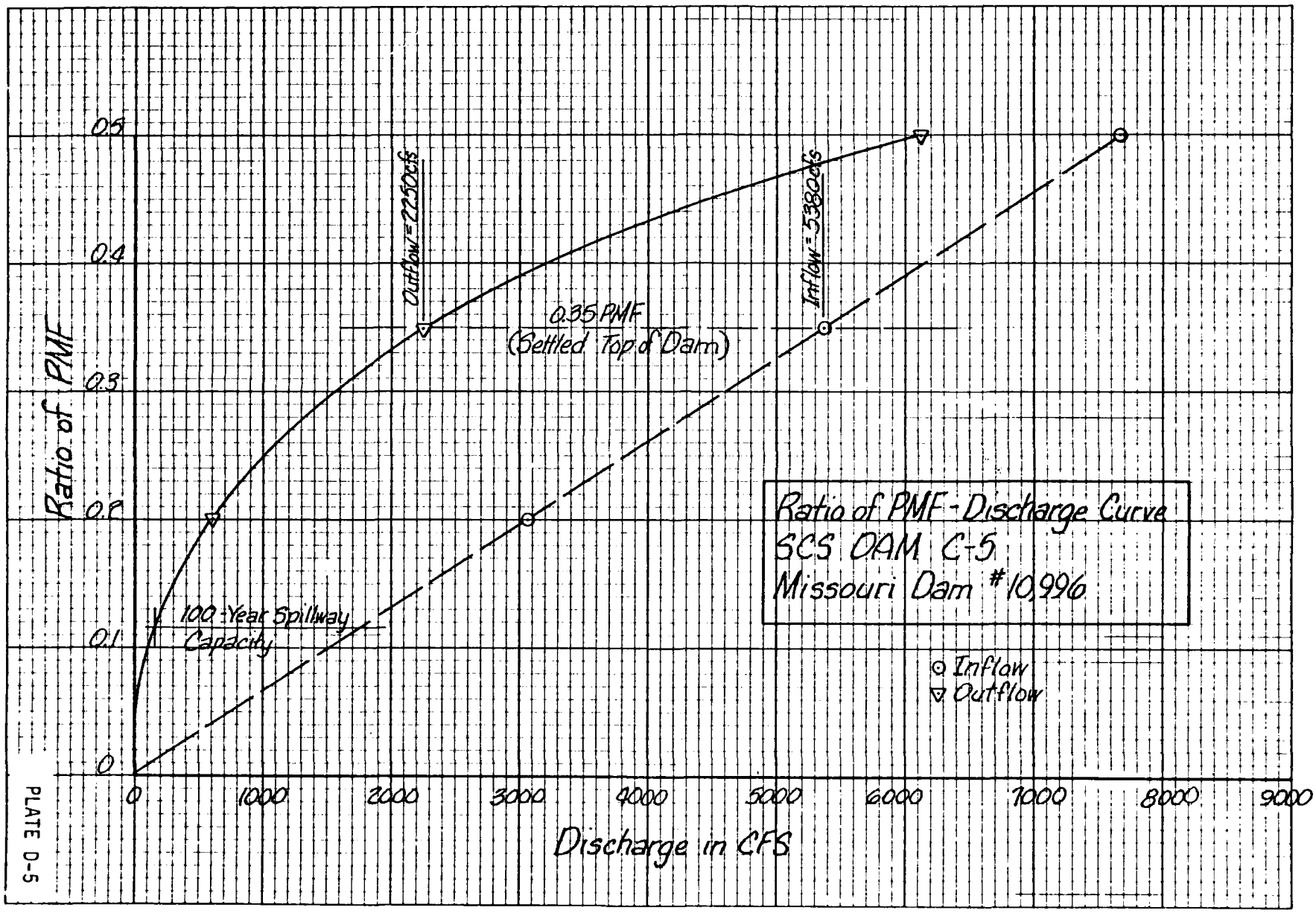


PLATE D-5

PMF Input Data

```
A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF SCS STRUCTURE C-5-10996
A3       RATIOS OF PMF ROUTED THROUGH THE RESERVOIR
B 0002880000000000000005                            00000000000000000000003
B1000005
J 000001000000360000001
J1000.2000000.3500060.5000000.6500000.80000001.0
K 0C00000000001                   0              1
K1       CALCULATION OF INFLOW HYDROGRAPH TO 10996 RES
M 000001000000720002.185          0002.185    1.0                00000001
P        000023.700000102000001210000130
T                                                -1.0      -89.
W2       0000.472
X 000000-.01    00000001
K 000001000000002                 2              00000001
K1       ROUTED FLOWS THRU 10996 RES
Y                       0000000100000001
Y1000001                                         -1051.0    -1
Y40001051001051.500001052000010530000105400001055000010560000105700001058000001059
Y4001060000010610010 61.50000106200001063000010640000106500001066000010670000001068
Y50000000003004.3900019.2600027.2400033.3600038.5200043.0700037.8000147.1100153.08
Y5152.9900190.8500282.2600438.6600861.4201434.1302166.8002994.4304022.9205054.57
$S00000000007.5000000350000008C000001300000018500000240000000310000003850000C0465
$S00056000000680000007800000091C00001060000012250000 1420
$E001037000010400000104200001044000010460000104800001050000010520000105400001056
$E0010580000106000001062000010640000106600001068000001070
$$1051.0
$D1065.1000003.0000001.500000850
K 000099
A
A
A
A
A
```

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 79/06/20.
TIME= 16.06.27.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF SCS STRUCTURE C-5-10996
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR

PMF Output Data

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	3	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1

RTIOS=	.20	.35	.50	.65	.80	1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPH TO 10996 RES

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000001	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	2.19	0.00	2.19	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.70	102.00	121.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRIL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-89.00	0.00	0.00

CURVE NO = -89.00 WETNESS = -1.00 EFFECT CN = 89.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .47

RECESSION DATA
STRTQ= 0.00 QRCSN= -.01 RTIOR= 1.00

UNIT HYDROGRAPH 30 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .47 VOL= 1.00

151.	451.	922.	1517.	1924.	2049.	1990.	1770.	1479.	1105.
823.	630.	494.	381.	288.	222.	171.	131.	100.	77.
59.	46.	35.	27.	21.	17.	13.	9.	6.	3.

PLATE D-7

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7685.	2756.	859.	859.	247272.
CMS	218.	78.	24.	24.	7002.
INCHES		11.73	14.62	14.62	14.62
MM		298.05	371.38	371.38	371.38
AC-FT		1367.	1703.	1703.	1703.
THOUS CU M		1686.	2101.	2101.	2101.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9990.	3583.	1116.	1116.	321453.
CMS	283.	101.	32.	32.	9103.
INCHES		15.25	19.01	19.01	19.01
MM		387.47	482.79	482.79	482.79
AC-FT		1777.	2214.	2214.	2214.
THOUS CU M		2192.	2731.	2731.	2731.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	12296.	4410.	1374.	1374.	395635.
CMS	348.	125.	39.	39.	11203.
INCHES		18.77	23.39	23.39	23.39
MM		476.88	594.20	594.20	594.20
AC-FT		2187.	2725.	2725.	2725.
THOUS CU M		2697.	3361.	3361.	3361.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	15370.	5512.	1717.	1717.	494544.
CMS	435.	156.	49.	49.	14004.
INCHES		23.47	29.24	29.24	29.24
MM		596.10	742.76	742.76	742.76
AC-FT		2733.	3406.	3406.	3406.
THOUS CU M		3372.	4201.	4201.	4201.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTED FLOWS THRU 10996 RES

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000002	1	0	0	2	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT

PLATE D-8

1 0 0 0.000 0.000 0.000 -1051. -1

STAGE	1051.00	1051.50	1052.00	1053.00	1054.00	1055.00	1056.00	1057.00	1058.00	1059.00
	1060.00	1061.00	1061.50	1062.00	1063.00	1064.00	1065.00	1066.00	1067.00	1068.00
FLOW	0.00	4.38	19.26	27.24	33.36	38.52	43.07	97.80	147.11	150.08
	152.99	190.85	282.26	438.66	861.42	1434.13	2166.80	2994.43	4022.02	5054.57

CAPACITY=	0.	8.	35.	80.	130.	185.	240.	310.	385.	465.
	560.	668.	780.	910.	1060.	1225.	1420.			
ELEVATION=	1037.	1040.	1042.	1044.	1046.	1048.	1050.	1052.	1054.	1056.
	1058.	1060.	1062.	1064.	1066.	1068.	1070.			

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1051.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1065.1	3.0	1.5	650.

STATION 000002, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
2.	2.	2.	2.	2.	3.	3.	3.	3.	4.
4.	4.	5.	6.	7.	8.	9.	10.	11.	12.
12.	13.	14.	15.	16.	17.	18.	19.	20.	20.
20.	20.	21.	21.	21.	21.	22.	22.	22.	22.
23.	23.	23.	23.	24.	24.	24.	24.	25.	25.
25.	25.	26.	26.	26.	26.	27.	27.	27.	27.
28.	28.	28.	28.	28.	29.	29.	29.	29.	30.
30.	31.	31.	32.	32.	33.	34.	34.	35.	35.
36.	36.	37.	38.	38.	39.	39.	40.	41.	41.
42.	42.	43.	49.	56.	63.	70.	77.	84.	91.
98.	104.	111.	117.	123.	130.	138.	147.	148.	149.
150.	151.	152.	153.	163.	173.	182.	190.	221.	249.
274.	306.	340.	371.	398.	423.	447.	471.	492.	511.
527.	541.	554.	565.	576.	585.	593.	600.	605.	608.
607.	603.	595.	584.	571.	556.	540.	523.	506.	489.
472.	456.	440.	426.	413.	400.	388.	376.	364.	353.
342.	332.	322.	312.	302.	293.	285.	279.	274.	269.
265.	260.	256.	251.	247.	243.	239.	235.	231.	227.
223.	220.	216.	213.	209.	206.	203.	200.	197.	194.
191.	190.	190.	189.	188.	188.	187.	187.	186.	185.
185.	184.	184.	183.	183.	182.	181.	181.		

STORAGE

275.	275.	275.	275.	275.	275.	275.	275.	275.	275.
275.	275.	275.	275.	275.	275.	275.	275.	275.	275.
275.	275.	275.	275.	275.	275.	275.	275.	275.	275.
275.	275.	275.	275.	275.	275.	275.	275.	275.	275.
275.	275.	276.	276.	276.	276.	276.	276.	276.	276.

OVRI

STATION 000002, PLAN 1, RATIO 3 **0.5 PMF**

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	2.	2.	2.	2.	2.	2.	2.
2.	2.	2.	2.	2.	3.	3.	3.	3.	4.
4.	5.	7.	9.	10.	12.	14.	16.	18.	20.
20.	21.	21.	22.	22.	23.	24.	24.	25.	25.
26.	27.	27.	28.	28.	29.	29.	30.	30.	31.
31.	32.	32.	33.	33.	34.	34.	34.	35.	35.
36.	36.	36.	37.	37.	38.	38.	38.	39.	39.
40.	40.	40.	41.	41.	41.	42.	42.	42.	43.
44.	47.	51.	54.	58.	62.	66.	70.	76.	83.
90.	99.	107.	116.	126.	135.	145.	148.	148.	149.
149.	150.	150.	151.	152.	152.	154.	162.	171.	179.
188.	219.	261.	319.	392.	468.	551.	633.	711.	788.
862.	957.	1046.	1130.	1213.	1299.	1404.	1554.	1763.	2034.
2512.	3740.	4955.	5758.	6114.	6094.	5823.	5436.	5013.	4602.
4235.	3919.	3651.	3432.	3250.	3098.	2968.	2853.	2748.	2652.
2563.	2483.	2412.	2350.	2298.	2258.	2232.	2206.	2177.	2142.
2100.	2046.	1982.	1910.	1832.	1750.	1667.	1584.	1503.	1426.
1357.	1291.	1228.	1167.	1109.	1055.	1003.	953.	907.	863.
831.	802.	773.	746.	720.	695.	671.	648.	627.	606.
586.	567.	548.	531.	514.	498.	483.	468.	454.	441.
430.	420.	410.	400.	391.	382.	373.	365.	357.	349.
342.	335.	328.	321.	315.	308.	302.	297.	291.	286.
281.	279.	276.	273.	270.	268.	265.	262.		

STORAGE

275.	275.	275.	275.	275.	275.	275.	275.	275.	275.
275.	275.	275.	275.	275.	275.	275.	275.	275.	275.
275.	275.	275.	275.	275.	275.	275.	275.	275.	275.
275.	275.	275.	275.	275.	275.	276.	276.	276.	276.
276.	276.	276.	276.	277.	277.	277.	277.	277.	278.
278.	278.	278.	279.	279.	279.	279.	280.	280.	280.
280.	281.	281.	281.	281.	282.	282.	282.	283.	283.
283.	284.	284.	284.	285.	285.	286.	287.	288.	290.
291.	293.	295.	297.	300.	302.	304.	307.	309.	312.
314.	317.	319.	322.	325.	328.	330.	333.	336.	339.
342.	345.	348.	351.	354.	357.	360.	363.	366.	369.
372.	375.	378.	381.	384.	387.	390.	393.	396.	399.
402.	406.	409.	412.	415.	418.	421.	424.	427.	431.
434.	437.	440.	443.	446.	450.	453.	456.	459.	462.
465.	469.	472.	475.	478.	481.	485.	489.	494.	499.
506.	513.	522.	530.	539.	549.	558.	568.	578.	588.
599.	610.	622.	633.	645.	657.	670.	682.	695.	707.
720.	733.	745.	759.	772.	785.	797.	810.	822.	834.
845.	856.	866.	876.	885.	895.	907.	922.	944.	971.
1004.	1034.	1056.	1070.	1076.	1076.	1071.	1065.	1057.	1050.
1043.	1037.	1032.	1027.	1023.	1019.	1016.	1013.	1011.	1008.
1005.	1002.	1000.	998.	995.	993.	991.	989.	986.	983.
978.	973.	966.	959.	951.	942.	934.	925.	917.	909.
901.	894.	887.	880.	873.	867.	861.	855.	850.	845.

840.	836.	831.	827.	823.	819.	816.	812.	809.	806.
803.	800.	797.	794.	792.	789.	787.	785.	782.	780.
778.	777.	775.	773.	771.	770.	768.	767.	765.	764.
763.	761.	760.	759.	758.	757.	756.	755.	754.	753.
752.	751.	750.	749.	748.	747.	747.	746.		

STAGE

1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0
1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0
1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0
1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0	1051.0
1051.0	1051.0	1051.0	1051.0	1051.0	1051.1	1051.1	1051.1	1051.1	1051.1
1051.1	1051.1	1051.1	1051.1	1051.1	1051.1	1051.1	1051.1	1051.1	1051.1
1051.2	1051.2	1051.2	1051.2	1051.2	1051.2	1051.2	1051.2	1051.2	1051.2
1051.2	1051.2	1051.3	1051.3	1051.3	1051.3	1051.3	1051.3	1051.4	1051.4
1051.5	1051.5	1051.6	1051.6	1051.7	1051.8	1051.8	1051.9	1052.0	1052.0
1052.1	1052.2	1052.3	1052.3	1052.4	1052.5	1052.5	1052.6	1052.7	1052.8
1052.9	1052.9	1053.0	1053.1	1053.2	1053.2	1053.3	1053.4	1053.5	1053.6
1053.6	1053.7	1053.8	1053.9	1054.0	1054.0	1054.1	1054.2	1054.3	1054.4
1054.4	1054.5	1054.6	1054.7	1054.7	1054.8	1054.9	1055.0	1055.1	1055.1
1055.2	1055.3	1055.4	1055.5	1055.5	1055.6	1055.7	1055.8	1055.9	1055.9
1056.0	1056.1	1056.1	1056.2	1056.3	1056.3	1056.4	1056.5	1056.6	1056.7
1056.9	1057.0	1057.2	1057.4	1057.6	1057.8	1058.0	1058.1	1058.3	1058.5
1058.7	1058.9	1059.1	1059.4	1059.6	1059.8	1060.0	1060.3	1060.5	1060.7
1060.9	1061.2	1061.4	1061.6	1061.9	1062.1	1062.3	1062.5	1062.6	1062.8
1063.0	1063.2	1063.3	1063.5	1063.6	1063.8	1063.9	1064.2	1064.4	1064.8
1065.2	1065.6	1066.0	1066.1	1066.2	1066.2	1066.1	1066.1	1066.0	1065.9
1065.8	1065.7	1065.6	1065.6	1065.5	1065.5	1065.4	1065.4	1065.3	1065.3
1065.3	1065.2	1065.2	1065.2	1065.1	1065.1	1065.1	1065.0	1065.0	1065.0
1064.9	1064.8	1064.7	1064.6	1064.5	1064.4	1064.3	1064.2	1064.1	1064.0
1063.9	1063.8	1063.6	1063.5	1063.4	1063.3	1063.2	1063.2	1063.1	1063.0
1062.9	1062.9	1062.8	1062.7	1062.7	1062.6	1062.5	1062.5	1062.4	1062.4
1062.3	1062.3	1062.3	1062.2	1062.2	1062.1	1062.1	1062.1	1062.0	1062.0
1062.0	1061.9	1061.9	1061.9	1061.8	1061.8	1061.8	1061.8	1061.7	1061.7
1061.7	1061.7	1061.6	1061.6	1061.6	1061.6	1061.6	1061.5	1061.5	1061.5
1061.5	1061.5	1061.5	1061.4	1061.4	1061.4	1061.4	1061.4		

PEAK OUTFLOW IS 6114. AT TIME 16.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6114.	2175.	622.	622.	179005.
CMS	173.	62.	18.	18.	5069.
INCHES		9.26	10.58	10.58	10.58
MM		235.20	268.85	268.85	268.85
AC-FT		1079.	1233.	1233.	1233.
THOUS CU M		1330.	1521.	1521.	1521.

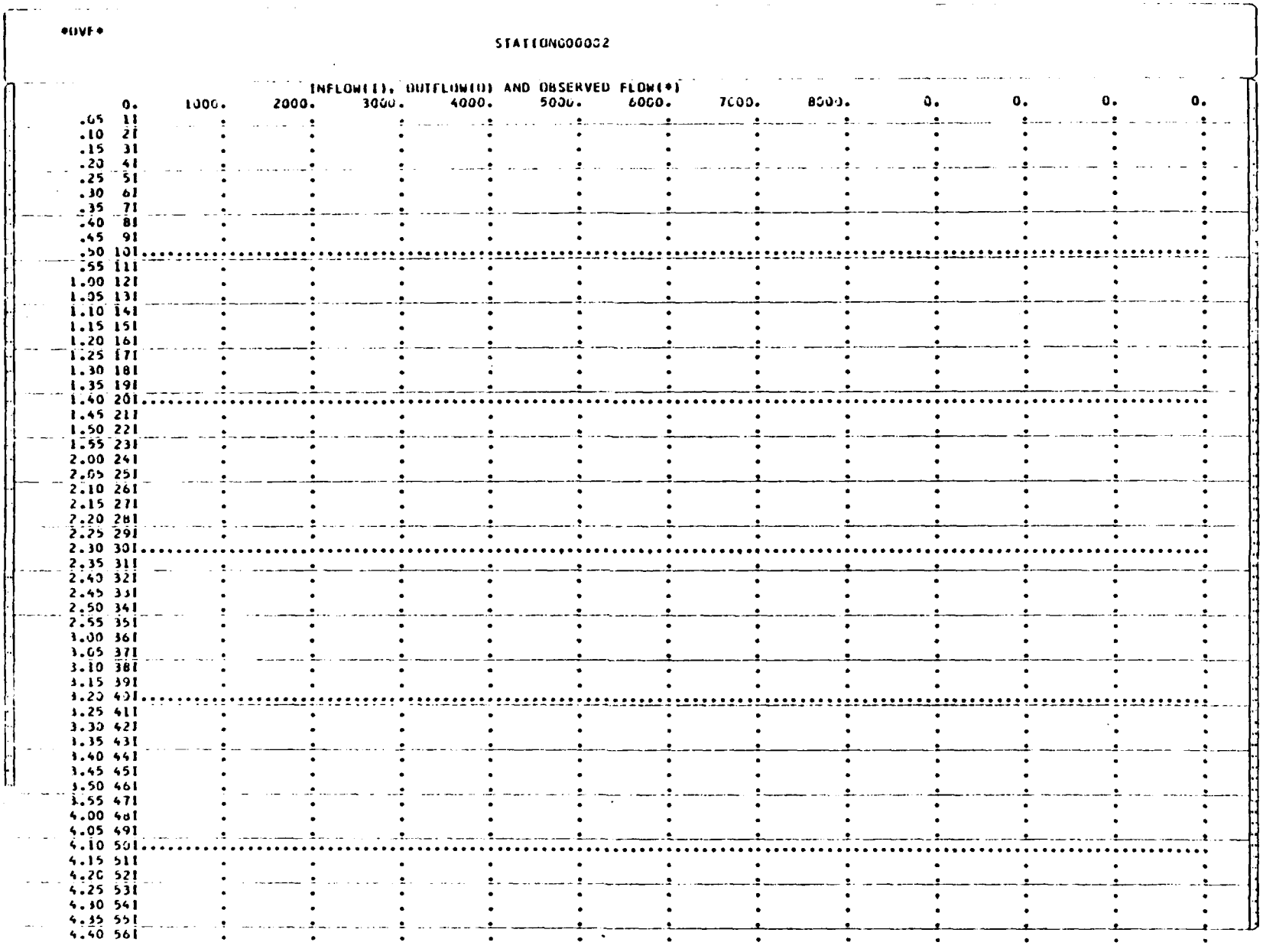

OVF
STATION00002
INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)
0. 1000. 2000. 3000. 4000. 5000. 6000. 7000. 8000. 0. 0. 0. 0.
.05 11
.10 21
.15 31
.20 41
.25 51
.30 61
.35 71
.40 81
.45 91
.50 101
.55 111
1.00 121
1.05 131
1.10 141
1.15 151
1.20 161
1.25 171
1.30 181
1.35 191
1.40 201
1.45 211
1.50 221
1.55 231
2.00 241
2.05 251
2.10 261
2.15 271
2.20 281
2.25 291
2.30 301
2.35 311
2.40 321
2.45 331
2.50 341
2.55 351
3.00 361
3.05 371
3.10 381
3.15 391
3.20 401
3.25 411
3.30 421
3.35 431
3.40 441
3.45 451
3.50 461
3.55 471
4.00 481
4.05 491
4.10 501
4.15 511
4.20 521
4.25 531
4.30 541
4.35 551
4.40 561

PLATE D-12

4.45 57
4.50 581
4.55 591
5.00 601
5.05 611
5.10 621
5.15 631
5.20 641
5.25 651
5.30 661
5.35 671
5.40 681
5.45 691
5.50 701
5.55 711
6.00 720
6.05 730
6.10 740
6.15 750
6.20 760
6.25 770
6.30 780
6.35 790
6.40 800
6.45 810
6.50 820
6.55 830
7.00 840
7.05 850
7.10 860
7.15 870
7.20 880
7.25 890
7.30 900
7.35 910
7.40 920
7.45 930
7.50 940
7.55 950
8.00 960
8.05 970
8.10 980
8.15 990
8.201000
8.251010
8.301020
8.351030
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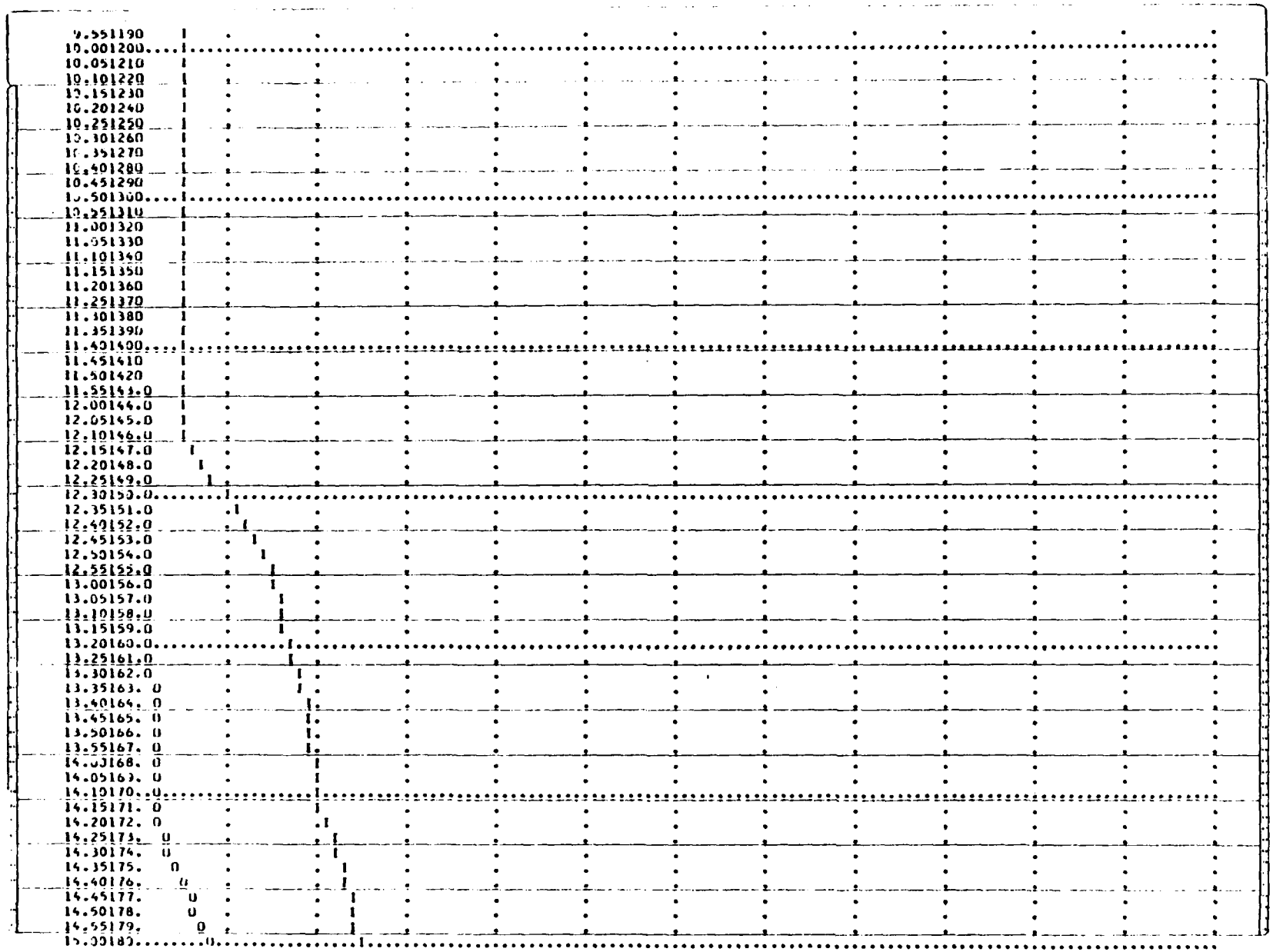
PLATE D-13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10.401280
10.451290
10.501300
10.251310
11.001320
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13.35163. 0
13.40164. 0
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14.15171. 0
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14.25173. 0
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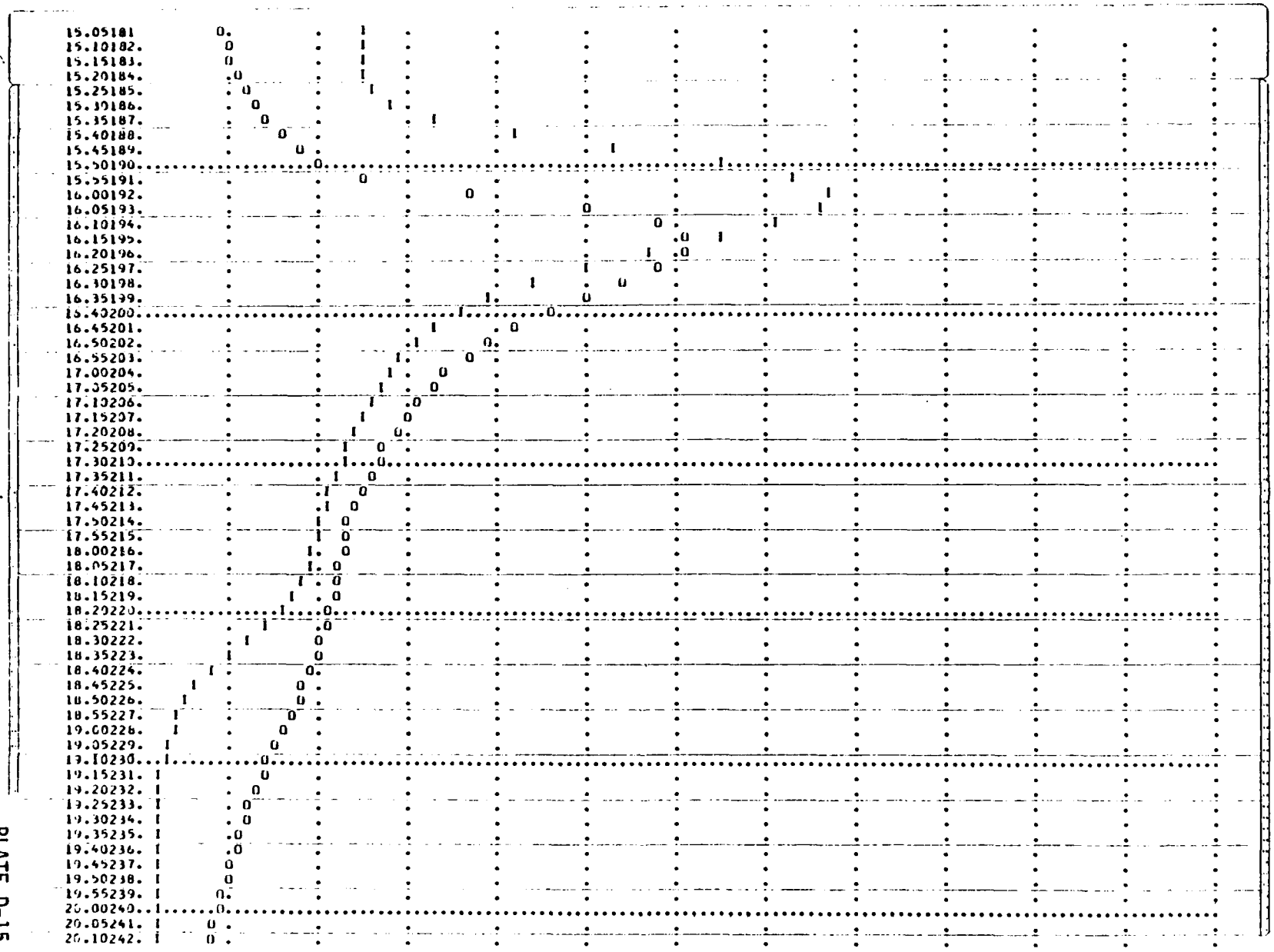
PLATE D-14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15.40188.
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16.15195.
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17.40212.
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18.20220
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20.10242.

PLATE D-15

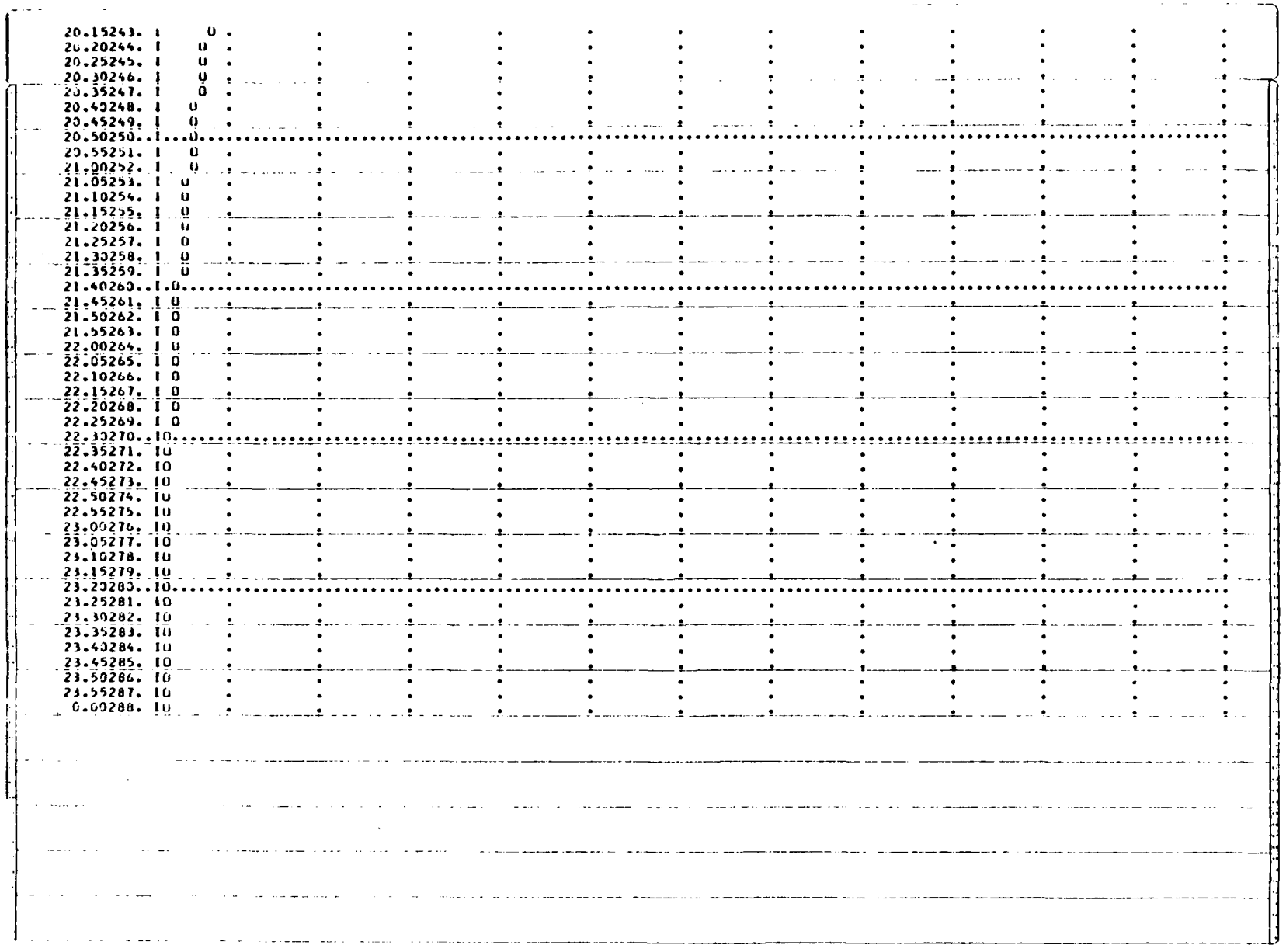

PLATE D-16

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS					
				RATIO 1 .20	RATIO 2 .35	RATIO 3 .50	RATIO 4 .65	RATIO 5 .80	RATIO 6 1.00
HYDROGRAPH AT	000001	2.19	1	3074.	5379.	7685.	9990.	12296.	15370.
		(5.66)	(	87.05)(	152.33)(	217.61)(	282.90)(	348.18)(	435.23)(
ROUTED TO	000002	2.19	1	608.	2248.	6114.	8936.	11264.	14253.
		(5.66)	(	17.20)(	63.65)(	173.14)(	253.03)(	318.96)(	403.61)(

AD-A105 326 HOSKINS-WESTERN-SONDEREGGER INC LINCOLN NE F/G 13/13
NATIONAL DAM SAFETY PROGRAM. 102 RIVERS, C-5 DAM (MO 10996), MI--ETC(U)
MAY 79 R S DECKER, G JAMISON, G ULMER DACW43-79-C-0046
UNCLASSIFIED NL

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..... INITIAL VALUE SPILLWAY CREST TOP OF DAM

ELEVATION	1051.00	1051.00	1065.10
STORAGE	275.	275.	992.
OUTFLOW	0.	0.	2250.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1062.40	0.00	806.	608.	0.00	18.33	0.00
.35	1065.10	0.00	992.	2248.	0.00	16.75	0.00
.50	1066.19	1.09	1076.	6114.	2.17	16.25	0.00
.65	1066.71	1.61	1119.	8936.	3.08	16.17	0.00
.80	1067.09	1.99	1150.	11264.	4.00	16.17	0.00
1.00	1067.53	2.43	1187.	14253.	4.83	16.17	0.00

PLATE D-18


DAT
FILM